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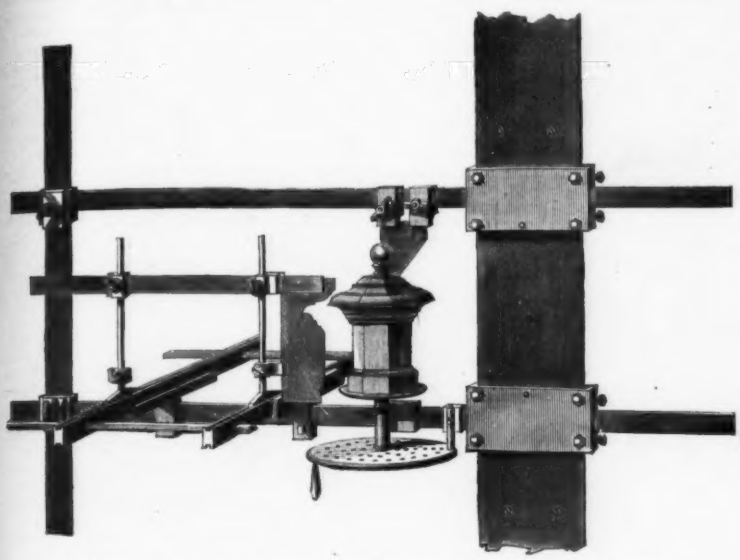


FIG. 1.—APPARATUS FOR SWEEPING PRISMATIC AND CIRCULAR PATTERNS.

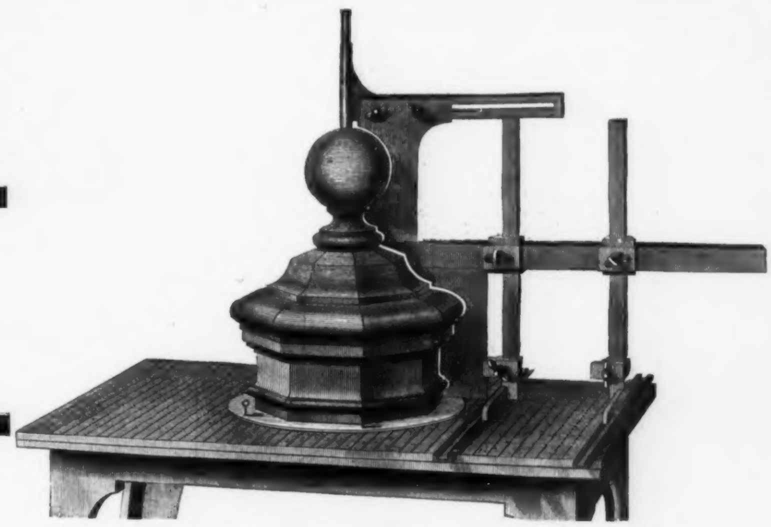


FIG. 4.—SIMPLE PLAN FOR SWEEPING RING AND POLYGONAL FIGURES.

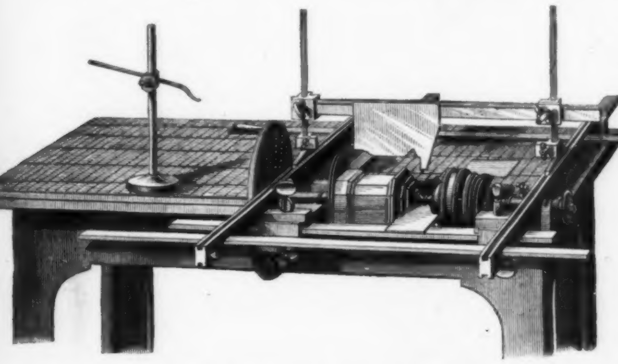


FIG. 2.—TABLE ON WHICH PATTERNS ARE SWEPT.

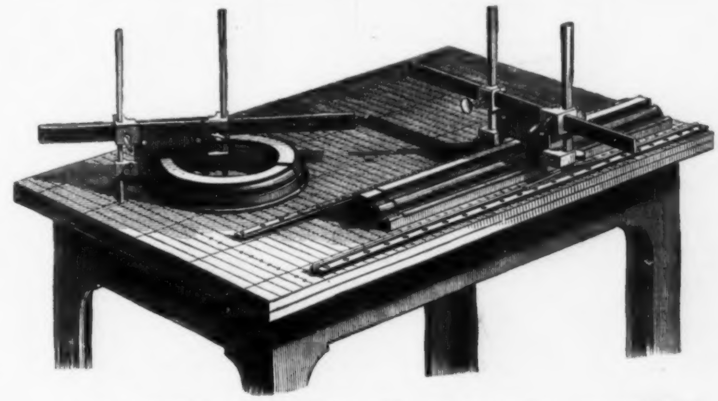


FIG. 3.—APPARATUS FOR SWEEPING RING AND ORNAMENTAL FIGURES.

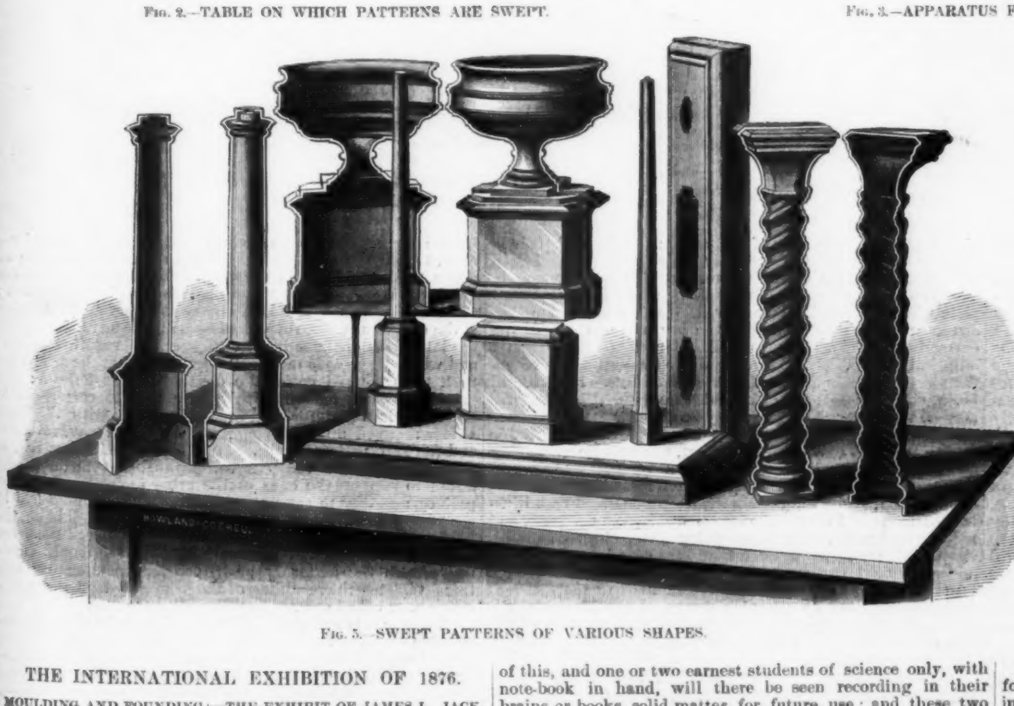


FIG. 5.—SWEPT PATTERNS OF VARIOUS SHAPES.

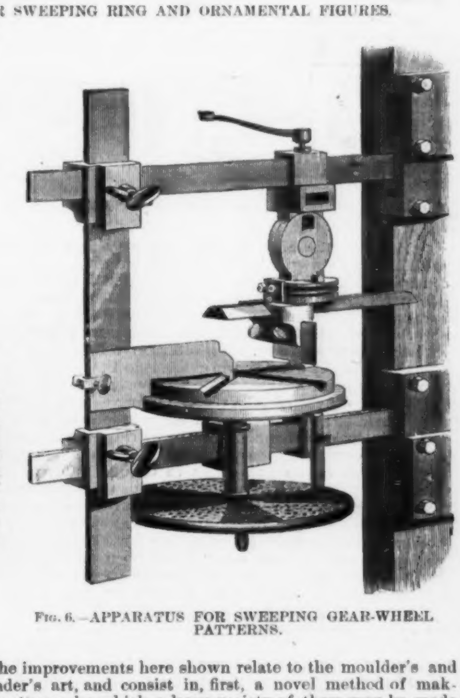


FIG. 6.—APPARATUS FOR SWEEPING GEAR-WHEEL PATTERNS.

THE INTERNATIONAL EXHIBITION OF 1876.

MOULDING AND FOUNDING.—THE EXHIBIT OF JAMES L. JACKSON & CO., IN MACHINERY HALL.

No. 28.

IN a stroll through Machinery Hall one encounters at certain locations, and invariably, a dense crowd deeply interested in some such operation as fancy wood-turning, band-sawing, glass-blowing, or candy-making; and to the mere curious sightseer they no doubt convey the impression that these are quite important mechanical results. At equally well-marked localities will be as invariably found the reverse of this, and one or two earnest students of science only, with note-book in hand, will there be seen recording in their brains or books solid matter for future use; and these two classes of exhibits will always be found to be of real value to the mechanical and scientific world in the inverse proportion of the numbers in attendance on them. In this building the man in search of real and valuable mechanical information may, therefore, and fortunately for him, avoid all crowded spots and be sure that he loses nothing in so doing. Among these apparently deserted exhibits is that indicated at the head of this letter; and nothing is hazarded in saying that there are few displays made at the Exhibition which exceed this in far-reaching importance to the mechanic arts.

The improvements here shown relate to the moulder's and founder's art, and consist in, first, a novel method of making patterns, by which a large variety of them may be made far better and cheaper than by methods previously used; and, second, the casting of objects containing members of very unequal volume—such as usually are very difficult or impossible to cast without the retention in them of destructive internal strains—practically without any such strains.

In the making of any piece of cast work for the first time, and particularly that of an ornamental character, it is well known that by far the largest part of the expense is generally incurred in providing the patterns; and so important an item is this in all large establishments, that a very considerable

part of the capital employed in machine-building concerns, foundries, etc., lies stowed away, almost a dead loss, in the pattern loft. Any thing, therefore, which will facilitate or cheapen pattern-making, must be classed among the most important of industrial advances.

The prime feature of Mr. Jackson's improvement in patterns is that of applying the principle of "sweeping"—to all intents and purposes the same as has been used in the production of the mould itself more or less for many years—to the production of patterns in plaster of Paris; and in the making of all such patterns as would be required for the character of work shown in Fig. 5—thin, hollow columns, etc., of an exactly equal thickness throughout, and providing against their becoming deformed in ramming in the mould, by having a base or solid core of plaster of exactly symmetrical form inside of the thin pattern. In a very large proportion of such work, too, all the expense of making cores and core boxes is dispensed with, the core being moulded and constituted of green sand just as with the cope and nowel of the mould, effecting altogether a great saving.

The making of patterns from plaster of Paris is by no means new, even as applied to plain structures; and especially is there nothing novel in such a use of this substance where work of an ornamental character is to be produced. Nor is there any thing new in the processes of "sweeping," shown in the illustrations, except in the detailed arrangements and sundry ingenious devices resorted to by Mr. Jackson to facilitate the operations; but previous to the introduction of this invention by Mr. Jackson, nothing like the "sweeping" of *patterns* had been attempted. Plaster of Paris, although found by experiment to be very generally preferable for this work, is not by any means the only material which may be used in this way, and other plastic materials differing as to tenacity and rapidity of hardening are used for special patterns.

found much better, and cheaper too, where much of this kind of work is to be done, to have it thus equipped. To this table is secured an adjustable frame in which is carried a spindle. On one end of this spindle is an index plate, by means of which it may be secured in the positions required for the production of the various prismatic forms used in ornamental work, such as the octagon, hexagon, pentagon, etc. The object to be swept, if either a solid of revolution or of prismatic outline, or a compound of the two, is formed upon this spindle. If it is to possess considerable bulk, a rough approximation in wood is first secured to the spindle to save plastic material, and upon it the latter is laid in sufficient thickness to form the particular figure required. To form that part of the pattern which is to be a solid of revolution, a template or sweep the reverse of the outline of the figure is attached to the frame, which removes the surplus plaster as the spindle is rotated. Athwart the table, and forming a part of the frame, are seen two grooved pieces in which slide two standards, carrying a cross-bar to which is attached a sweep os template, which, in like manner, removes the surplur plaster as it is moved back and forth over the pattern, while the spindle is held in place by a pin in a hole of the index wheel, the operation being repeated as many times as the figure is to have sides. The cross-bar carrying this sweep is adjustable vertically upon the sliding standards; so that one half of the sides thus swept may, if desired, be of different dimensions from the other half, resulting in an approach to a square figure with truncated corners, as is shown in the cut; and in this way many variations in prismatic figures may be formed. It will be seen that only a portion of the curved surface of the pattern forming a kind of neck between the prismatic and the larger curved part is shown as being swept, and at the base of the prismatic part is seen a thin oval plate, which is secured upon the spindle in such position that the major and minor axes are perpendicular to the principal faces

shown, which carries the sweep. In this case, in being moved back and forth, it forms the recesses in which the arms are to be moulded Fig. 7 shows the same apparatus with the V slide placed vertically for the formation of the teeth, while the stationary sweep forms the sides and periphery of the rim. In the same way, by placing the slide at the required angle, the teeth of bevel wheels may be swept.

In the construction of a set of apparatus of this kind, it is not necessary to make the complete machine in each case, but a general form of it can be made, which, with the change or addition of one or more pieces, will answer for a very large variety of work. Several other forms of it may be seen at the works of Mr. Jackson, at First and Second avenues, between Twenty-eighth and Twenty-ninth streets, New York.

The operations above described apply both to the hollow pattern, and the solid core or base, where hollow patterns are required. Taking the urn in Fig. 2 again as a specimen figure, a solid piece of the form and dimensions required for the inside of the casting is first swept up, as already shown; then this core or base is varnished with shellac to prevent adhesion of the shell to be built upon it; and with sweeps of symmetrical contour, increased to allow the desired thickness of shell, a thin coat of plaster put upon this base is again swept up in the manner already described. After this operation, and before the plaster has fully hardened, the shell pattern is divided or cut through, on two opposite lines parallel with the axis of the spindle, with a very thin knife. The small amount of material removed by this knife is afterwards added to the edges of the half patterns, after removal from the base, in a liquid state. It will be readily understood that this operation must produce a thin hollow pattern in two exactly similar and equal parts, having an equal thickness throughout, or with such symmetrical variation of thickness as may be desired. Where the object to be cast admits of it, of course the proper "prints"

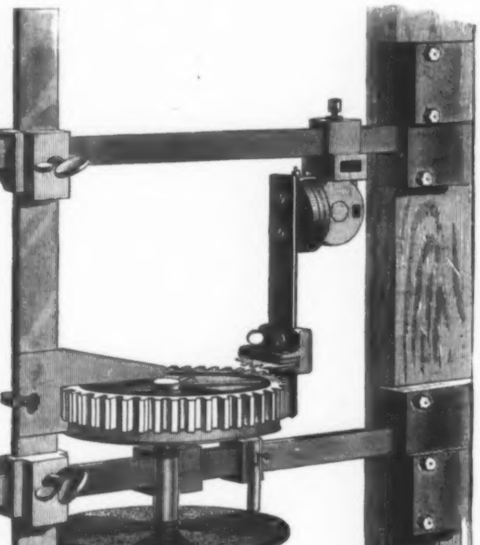


FIG. 7.—SAME AS FIG. 6, ADJUSTED FOR FORMING TEETH, ETC.

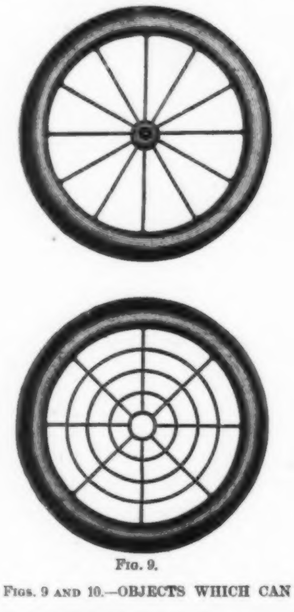


FIG. 9.

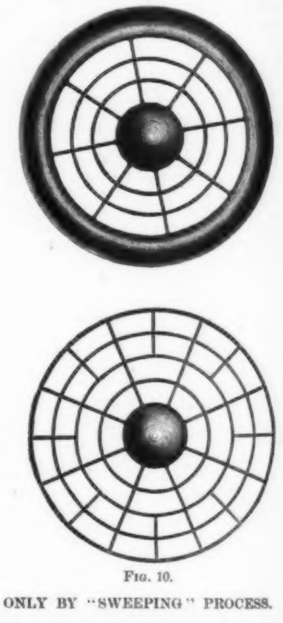


FIG. 10.

FIGS. 9 AND 10.—OBJECTS WHICH CAN BE CAST ONLY BY "SWEEPING" PROCESS.

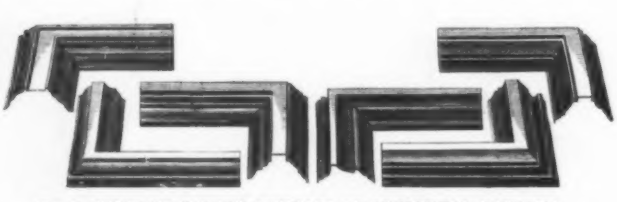


FIG 8.—MODE OF JOINING SECTIONS OF SOFT-METAL PATTERNS.

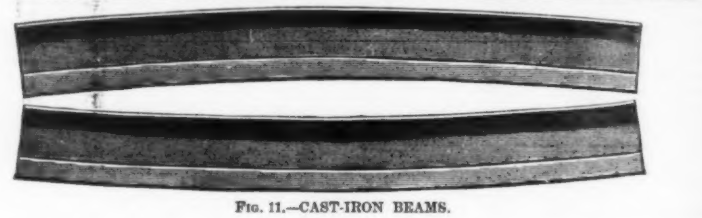


FIG. 11.—CAST-IRON BEAMS.

Aside from the advantages attending the production of patterns in this way, all of the plastic materials used in their construction possess properties in contradistinction to wood, which relieves the moulder from several of the most embarrassing features of his trade. Wood is a very ready absorbent of moisture, and even when well coated with shellac, as is customary, it is sufficiently hygroscopic to be affected seriously even by the changes in the humidity of the atmosphere, and still more disastrously by the moisture inseparably connected with the tempering of sand for "green-sand" moulds; moreover, any change in form or particularly in the dimensions of wooden patterns from the absorption of moisture, occurs very unequally in different directions, resulting in disproportion as well as in change in form and size. It may be thought that patterns such as are represented in Fig. 5, mere shells with a thickness of $\frac{3}{16}$ to $\frac{1}{4}$ of an inch, made of a somewhat fragile material and consequently easily broken, would be quite objectionable for that reason; but the method of making and using them upon solid symmetrical bases renders this a matter of no consequence whatever, for in case of the breaking of a pattern even into a number of quite small pieces, it may be as readily used as when intact, as will be seen when the method of using them is understood.

In the construction of these patterns the arrangement in Fig. 2 may be fairly taken as a typical one, while some of the variations possible to suit the different kinds of work are shown in Figs. 3, 4, 6, and 7; and, of course, these may be modified in many ways to conform to special cases. It is practicable to sweep patterns in this way of almost any form, except such as have irregular warped surfaces; even a helix, such as the thin blade of a continuous screw, can be formed in a similar manner, and a specimen of this kind of work is shown, cast from a pattern swept up in a short section, such that a repetition of it in the mould produced a long helical blade wound upon a small axis.

Fig. 2 shows a table with cast-iron top planed level and marked off in inches in both directions for convenience of measurement. The cast-iron top is not indispensable, but it is of the prism of the base of the pattern. This oval plate is made to bear against the cross-bar which carries the sweep for the curved parts of the figure, and this bar is made to slide to and from the axis of the spindle as guided by the oval plate when the spindle is revolved. In this way a suitable sweep or template secured upon the bar at the right of the one shown would sweep up a solid of revolution having an elliptical section. The figure resulting from all these operations is, as shown in the cut, that of a kind of urn with elliptical basin, circular stem, and octagonal base; and these features may be varied indefinitely, as may be desired.

Fig. 1 shows an arrangement in which the adjustable frame is secured to a vertical support, the spindle occupying and the work upon it being made in a vertical position; in this case only a small ball and neck on the top being of circular section, while the remainder is octagonal. Fig. 3 illustrates the method adopted to sweep up ring-like objects, and rectilinear figures, such as mouldings, etc. Fig. 4 shows a simpler plan of sweeping such figures as contain both circular and polygonal sections; the pattern being built upon a face-plate lying on the iron table, and held in the different positions required by the pins shown at the angles of the figure, the circular parts being swept by the rotation of the horizontal bar upon the spindle passing vertically through the pattern and table.

Fig. 6 shows an arrangement attached to a strong vertical support, designed for the sweeping up of gear wheels, either spur or bevel; and not only the rim and teeth, but the arms and hub as well. Upon a face-plate attached to the spindle is a bed of plaster, in which to mould again in plaster the arms, hub, and inside of the rim of a spur wheel. To the outside upright bar is attached a stationary sweep, which forms the recess for the hub, and the flat dividing surface of one half the bed, as the spindle is revolved. Attached to the upper horizontal bar is a sliding piece, secured in position by a set screw, carrying two disk joints with their axes at right angles to each other, providing what is practically a universal joint, upon which the V-shaped slide below the joint may be placed in any position required. Upon this slide a clamp is

for the support of the core is also swept upon the base piece. Now, to use these patterns, if the ordinary baked core of white sand and flour is used, the base serves for a pattern upon which to cast or mould two halves of a plaster core box; and this core box, beside being made at a very small fraction of the cost of a wooden one, possesses all the advantages over the latter that characterizes the plaster patterns themselves; and where the core is moulded in green sand at the same time with the cope and nowel, the operation is as follows: The base is cut down longitudinally to a half, to correspond to one of the half patterns, and the half pattern with this base in it is rammed up in the nowel in the usual way, reversed, and the half pattern drawn. An arbor, or stiffening rod, is then placed inside the pattern, prints being made in the nowel to support the ends of the arbor projecting from the pattern, and thus to support the core, and the whole laid in the nowel, and filled. The cope is now rammed, laid off, the half pattern drawn, laid on again, the mould reversed, the nowel lifted off, its half pattern drawn, and the mould closed up. With the necessary provisions for vents, gates, etc., this completes the moulding of the whole without the use of core box or baked core.

Of course it is understood that this kind of pattern is not suitable for large and heavy work; but for all kinds of ornamental work, stove and hollow ware, and light castings of almost any kind, it effects a large saving of money, in some cases costing not more than ten per cent of that required for and in the use of a similar pattern of wood.

Mr. Jackson extends this principle also to the formation of irregular ornamental work upon large castings for architectural purposes, particularly as applied to such ornamentation as is formed of repetitions of a generic figure. This is done by means of an auxiliary base, movable in a depression in the main pattern, upon which a curved or modelled base of the ornament itself is placed. He is now applying this method to the work for a large building. Where a pattern is required to be used a great many times, it is, as usual, made of iron from the plaster copy, but with careful use the latter will last a considerable time. In some varieties of work, such

as mouldings for stove work, a short section is made in plaster, which is reproduced in soft metal, and the sections joined by soldering, as shown in Fig. 8.

Another of Mr. Jackson's improvements in this line is that of successfully providing against the rupture or distortion of castings while cooling, or subsequently, as often happens through the internal strains brought upon the casting by the irregular cooling of the various members.

In the casting, for instance, of a large wheel, with rim heavy compared with the arms or spokes, as soon as the pouring is completed the cooling commences; and, as the molten iron is an excellent conductor and radiator of heat, the lighter portions soon attain a lower temperature than the heavy parts, and become solidified; after this first solidification takes place the trouble commences, and a crushing strain begins to take place in the solidified arms as the rim solidifies and shrinks upon them, while the resistance to this crushing in the arms brings a tensile strain in the rim; and these are the conditions which will obtain in such a casting if simply left to itself to cool. This is only a familiar instance, but the distortion or internal strain here indicated occurs in any casting whatever which contains members of unequal volume, and left to cool as it may; and the same holds good in castings of but one member, but of large volume, such as a large gun, which, if left to cool in the natural way, does so first on the outside, and this part becoming solidified first, unable to conform to the subsequent contraction of the interior, results in the destruction of the integrity of the metal in the central portions, and renders the ultimate strength of the casting far less than it would be if the interior and exterior could be simultaneously and equably cooled.

It was from these considerations that the well-known Rodman process of cooling large gun castings from the inside by the circulation of water was instituted by that gentleman. To put this in the most general terms, it may be said that, with any casting whatever, in order that it shall be absolutely without internal strain, either as between its several members or in the structure of a member itself, it must cool in all parts in such a way that at any period of such cooling the temperature must be the same throughout, and therefore the solidification must take place also simultaneously in all its parts. Now to effect a practical approximation to these conditions, it has been the practice, to some extent, to cool artificially the heavier members of a casting, or the interior of a large mass, as mentioned in the case of Rodman's invention; but in practice this plan has been found difficult of application to castings generally having diversified forms, and has for several reasons been only partially successful in ameliorating the difficulties indicated above. Mr. Jackson's invention is exactly the reverse of this, and may be very easily applied to almost any form of casting. It consists in making rough auxiliary patterns conforming to the spaces between the lighter members of a casting of such volume as to be practically equal to the heavier members, and making with them spaces in the sand of the mould in the parts between the light portions of the proposed casting with the proper gates, etc., for pouring them at the same time with the pouring of the mould proper. In this way he brings into close proximity with the lighter members of a casting a mass of molten metal which will cool practically at the same rate as the heavier members, thus preventing the more rapid cooling of the thin or light parts. In most cases this plan admits of a practical approach to the fundamental requirement, that all parts of a casting shall cool together and at the same rate. In Figs. 9 and 10 Mr. Jackson exhibits specimens of work in which disparity of volume in the several parts is purposely exaggerated, and which the moulder will see at a glance it would be impracticable, if not impossible, to cast in any other way without either rupture or considerable distortion. These four pieces may, however, be seen on exhibition, perfect in all parts, and, so far as tests with the hammer will determine, without internal strain. They were all cast in the way described.

Fig. 11 shows three cast-iron beams of a section shown at the right. In the casting of such an object, if the pattern be straight, not distorted in the moulding, and left to cool of itself, it would assume, when cold, an approximation to the curved form shown in the centre figure—that is, bent, with concave on the thickest flange; but, by casting a body of metal in proximity to the thin flange and web, Mr. Jackson has succeeded in curving such a piece in the contrary direction, as shown in the lower figure. The application of this principle to the making of iron patterns containing disproportionate members has a very considerable value, and has been largely resorted to in Mr. Jackson's establishment.

These inventions have now been in successful use for several years, but hitherto have not been brought very prominently before the public. Their very great value, however, will be apparent to all concerned in this branch of manufacture.

Mr. Jackson also exhibits several of his well-known steering wheels and other ship work in this building, as well as a very extensive display of his specialties in stable fixtures and similar work in Agricultural Hall. J. T. H.

THE INTERNATIONAL EXPOSITION OF 1876.

THE BURLEIGH ROCK DRILL.

ALTHOUGH it is scarcely ten years since the first Burleigh drill was brought before the public, there is now not a mining country in the world where the machine is not employed. It was used in the Hell Gate excavations, in the Hoosac tunnel, and is now working in the great Sutro tunnel into the Comstock lode, in the principal iron and copper mines of the Lake Superior region, and in many of the larger gold mines of Nevada.

The drills on exhibition in Machinery Hall are driven by compressed air from a Burleigh air compressor, which is actuated by a 75 horse power engine. The pressure is about 3 atmospheres, working under which the drill penetrates gneiss rock at the rate of 13 inches per minute. The drill itself is a solid bar of steel, which is rotated as it moves backward and forward by simple mechanism. The whole shock of the blow is borne by the piston rod, which also, by suitable devices, governs the valve admitting steam or compressed air into the cylinder, and moves the cylinder forward in the cage. When the cylinder has advanced to the entire length of the feed screw, it can be run back, and a longer drill can be inserted in the end of the piston. For drilling deep holes sectional drills can be introduced; and in this way a hole from thirty to thirty-five feet in depth can be made.

The $2\frac{1}{4}$ and $2\frac{1}{2}$ inch drills used in the Hoosac tunnel made progress at the rate of 60 feet daily for head work and 100 feet for vertical work. Similar machines in the Sutro tunnel make from 350 to 400 feet per month in a heading 8 x 10 feet, the rock there not being so hard as that in the Hoosac bore. A model of the Sutro tunnel is exhibited in the Burleigh drill display, showing how far the work has progressed, where it is to be further constructed, and how it will drain the Comstock lode, Ophir, Savage, and other mines. The total horizontal length is to be 13,200 feet, and the depth of the deepest shaft 1600 feet, or 600 feet more than the Hoosac central shaft.

THE BURLEIGH ROCK DRILL.

The air compressor embodies a number of ingenious and effective devices. By an adjustment of the cranks working the piston rods of the steam and compression cylinders, the piston of the steam cylinder does its heaviest work just as the pistons of the compression cylinders are called upon to exert the highest degree of power. A spray of cold water delivered into the air cylinder cools the compressed air and obviates its tendency to re-expand.

A neat little gold-plated model of the Burleigh drill has lately been made, and is quite a curiosity in its way. It weighs only 5 ounces, and yet will drill a hole of from $\frac{1}{8}$ to $\frac{1}{4}$ inch in diameter, through a block of marble an inch and a half thick. We give herewith an engraving from which the appearance of the Burleigh drill while at work will readily be understood.

THE USE OF THE MAGNETIC NEEDLE IN SEARCHING FOR MAGNETIC IRON ORE.*

THE magnetic and polaric properties of magnetite, or magnetic iron ore, are fundamental principles in magnetism. The disturbing effect of this mineral upon the magnetic needle in land-surveying must have been very early observed. The more general use of the magnetic needle for this purpose does not go back more than thirty years. In 1854, when the Geological Survey of New Jersey, under the direction of Dr. William Kitchell, began, the ordinary surveyor's compass was used by a few persons who were sufficiently experienced, or skilled by observation, to properly interpret their indications. At that time the number of large mines was not much greater than at the beginning of the century. The introduction of the miner's or dip compass shortly afterward, made the use of the needle much more convenient and extended, and work with it was done with much greater rapidity and accuracy than formerly. Contemporary with its introduction began the greater frequency of discoveries, and the opening of many new mines and ore localities, so that this might be taken as an era in iron-mining in New Jersey. Dr. Kitchell estimated the amount of iron ore raised in that State, in 1855, at 100,000 tons. In 1864 this had been increased to 264,000 tons, and in 1868 further, to about 300,000 tons. But the increase in the number of mines from 1868 to 1874 is most remarkable. In the first-named year there were 115 mines and mine-groups; whereas, in 1874 the number of mines and ore localities had increased to nearly 200 in number.

It may be safely stated that all of these were first made known by the use of the needle. Or, in other words, the average annual production of the State had been increased fully fifty per cent by the addition of these new producing localities found by the compass. So much the iron men owe to this little guide, or *true* divining-rod. It should also be stated that in many cases there are no surface indications of ore other than those of the compass.

At the present time nearly every mine superintendent, and many land-owners, have their dip compasses, and as opportunity offers, go out in search of new lines of attraction. A few persons follow this business as a specialty, and open mines and deal in mineral properties. They are known as "ore-hunters," or "prospectors," or "mineral dealers." For several years preceding the panic of 1873, the increasing demand for ore stimulated the search for new supplies, and many lines of attraction were found, and nearly every farm in this long belt was covered by a mineral lease.

MAGNETISM OF MINERALS AND ROCKS.

Magnetite is not, however, the only mineral which may disturb the needle and exhibit the deflection from the plane of the magnetic meridian termed *attraction*. Nor is this phenomenon of deflection confined to rocks containing this mineral. A large number of minerals are capable of producing slight deflection when they are brought near the needle. Serpentine, amphibole, pyroxene, hematite, and franklinite are some of the more powerful of these in their effects upon the magnetic needle. Many rocks also show some magnetism, particularly the darker colored, and more dense, igneous, and volcanic rocks. This applies to the rock in masses as well as in hand specimens. In nearly all cases the magnetic disturbance is increased by heating to fusion or by oxidation. Probably in all these cases the magnetism is closely related to the presence or formation of both ferrous and ferric oxides in the mineral or rock species. Many of these exhibit polarity as well as magnetism.

In practice the attraction is to be referred to the near presence of magnetic iron ore, although the converse is not always correct, since there is a great range in the magnetic intensity exerted by ores, and some are so slightly magnetic that the deflection is perceptible only when the experiments are made with extreme care. Thus it is possible to pass with a dip compass right over large veins of ore and yet fail to discover any attraction. Slight attractions over large and well known veins are common in New Jersey. But careful surveys will generally reveal the disturbing effect and indicate ore. On the other hand, strongly magnetic and polaric ores are also common. In some instances the attraction is felt powerfully through wide intervals of rock, or dirt, or air. Hence no conclusions can be safely drawn from the amount of deflection or the magnetic intensity. These differences in the ore render the work of observation in some localities extremely easy, while in others there is need of repeated work, and that done slowly and cautiously.

As a rule the surface ores are most thoroughly magnetic, and this fact makes the survey of unexplored ground more easy. This difference between surface and bottom ores can be seen at almost any mine in this region.

STYLES OF COMPASS.

Formerly the ordinary pocket box-compass, in which the needle is horizontal, was used in searching for attraction, the observer holding it in his hand, and noting from point to point the amount of deflection from the magnetic meridian. Sometimes, and where a more careful survey was required, the land-surveyor's compass was used, and then lines were run back and forth, across the course of the vein, sighting ahead and noting from point to point in these lines the bearing of the object toward which the line was directed. When these lines were properly located, and the points of observations fixed, and the several observations on them recorded, good work was done. But it was necessarily slow, as each observation required some time, particularly if the attraction was slight.

About ten years ago the miners' or dip compass was introduced. This has its needle balanced on a horizontal axis, and free to move in a vertical plane only. In the most common form this is from two to four inches in length, and is shut in a flat, circular brass box with glass sides, in some cases open, in more improved forms protected by movable brass plates or covers, which are taken off while in use. This style of compass has superseded the horizontal surveyors' instrument, and has come into very general use. It is often called the dipping needle or dip compass.

As in this form the needle can not move horizontally, care must always be taken to ascertain the magnetic meridian, and to hold the instrument in the plane of that meridian, otherwise the needle, under the influence of terrestrial magnetism alone, will assume an inclined or vertical position, and thus show a dip or attraction where, in reality, there is none. Neglect of this precaution has misled many an observer, and intentional disregard of it has very frequently deceived the ignorant or unsuspecting. The extent to which deception in this manner has been practised is hardly conceivable by those unacquainted with the magnetic iron-ore districts of the Highlands.

In Sweden, a miner's compass, having its needle mounted upon a pivotal joint, which allows of motion both vertically and horizontally, and inclosed in a glass sphere or cylindrical brass case, has been used in ore searches. But there is objection to this form in the unsteadiness of the needle, which has so much *play* that more time is requisite in making observations with it.

A newer form, designed by Prof. Cook, of the State Geological Survey of New Jersey, about five years ago, and constructed by W. Emeley, of Troy, removes the objection in the Swedish compass, by allowing the needle, which is balanced on its horizontal axis, to move horizontally through a small fraction of a great circle. This, therefore, shows the magnetic meridian much more quickly than the Swedish instrument; and then, if there be any attraction, it is manifested in the dip, avoiding any possible danger of deception through the action of the earth's magnetism upon a needle not placed in the magnetic meridian. This most improved compass has its movable brass sides, for safety in carrying, and the ordinary ring set in the brass edge, whereby to hold it. The graduated circle is the same as in the old form. Those who have had much experience in magnetic surveys give the preference to this compass, as the most accurate, convenient, and most efficient, either for rapid preliminary observations, or for detailed exploration.

In use, the compass is generally held about on a level with the eye of the observer, or so that he can conveniently watch the movement of the needle and read off the graduated circles the amount of dip. After some experience great dexterity is acquired, and from the vibrations the experienced eye can readily detect what will probably be the character and the amount of the dip or attraction. Such an observer may move along on a slow walk and observe, or, as it is technically termed, *catch* the attraction, if there be any in the course he may follow.

SURVEYS.

In a preliminary survey of any given tract, the usual practice is to go rather rapidly on zigzag lines, from northwest to southeast; or, if attraction be known or found at any given point, to walk northeastward and southwestward from that point, following on the supposed or assumed course of the ore, and thus ascertaining its longitudinal extent. This gives the general direction and length of the line or belt of attraction. This preliminary survey does not generally require more than a single line of observations, and these are not located or recorded, excepting so far as the observer may refer them in his memory to any landmarks that may be prominent or convenient for future observations.

Detailed surveys, or what may be properly termed "magnetic surveys," may be more or less varied, according as the nature of the attraction may seem to require a greater or less number of observations within a given area.

In general, the most convenient and most expeditious method, and, at the same time, that which is best suited to show the character of the attraction or observations, consists in taking observations on lines at right angles to the course of the vein, or across the belt or line of attraction. Where the prevailing course, or strike, is northeast and southwest, as in the Highlands, these should be northwest and southeast lines. Of course they may be at greater or less distances apart, according as the nature of the attraction may indicate, or the degree of detail demanded in the survey. In general, they may be from fifty to two hundred feet apart, or, in exceptional cases, as close as twenty feet. The stations or points of observation in these lines may likewise be at varying distances—from five to twenty-five feet apart. Ten feet has been found to be convenient and sufficiently close for careful and valuable surveys. Such detailed observations, to be of value, must be located and recorded; or, in other words, mapped. For this purpose it is easier to run parallel lines, or such as are approximately so, and make the observations at regular intervals.

Stakes may be driven at the ends of these, and a subsequent survey may be made to locate them. The observed dips, or the amount of attraction, can then be placed at fixed intervals on these lines. Such a method is much more expeditious than a far more detailed survey at *irregular* points. While a great deal of work has been done by the numerous prospectors in this iron ore district, and large areas have been covered by a network of closely placed observations, very little work has been recorded on maps.

* A paper read before the American Institute of Mining Engineers by Prof. J. C. Smock, of the State Geological Survey of New Jersey.

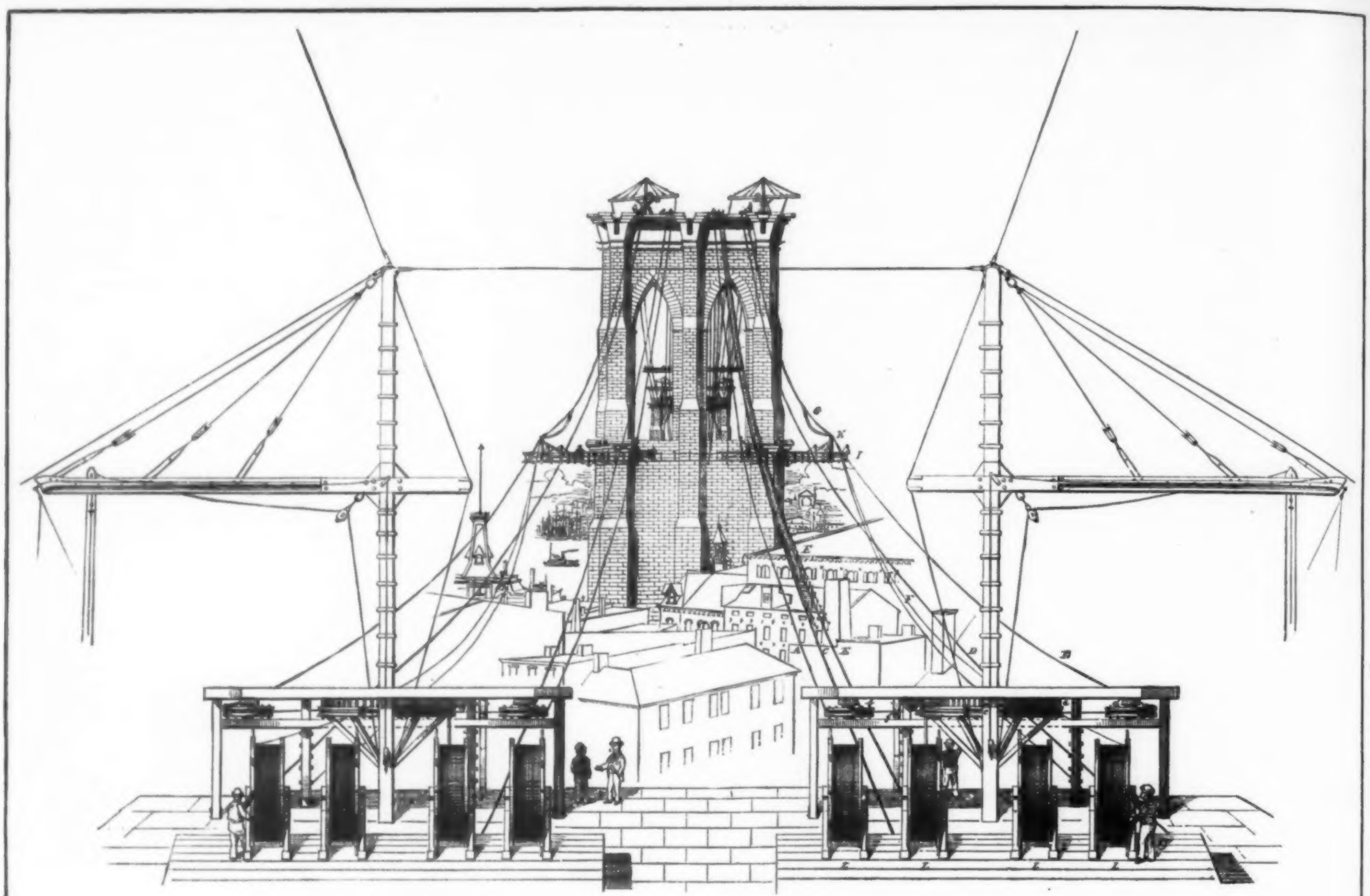


Fig. 3.—ARRANGEMENT OF CABLE DRUMS, FOOT BRIDGE, CRADLES, AND CABLES, BROOKLYN ANCHORAGE.

THE GREAT SUSPENSION BRIDGE BETWEEN NEW YORK AND BROOKLYN.

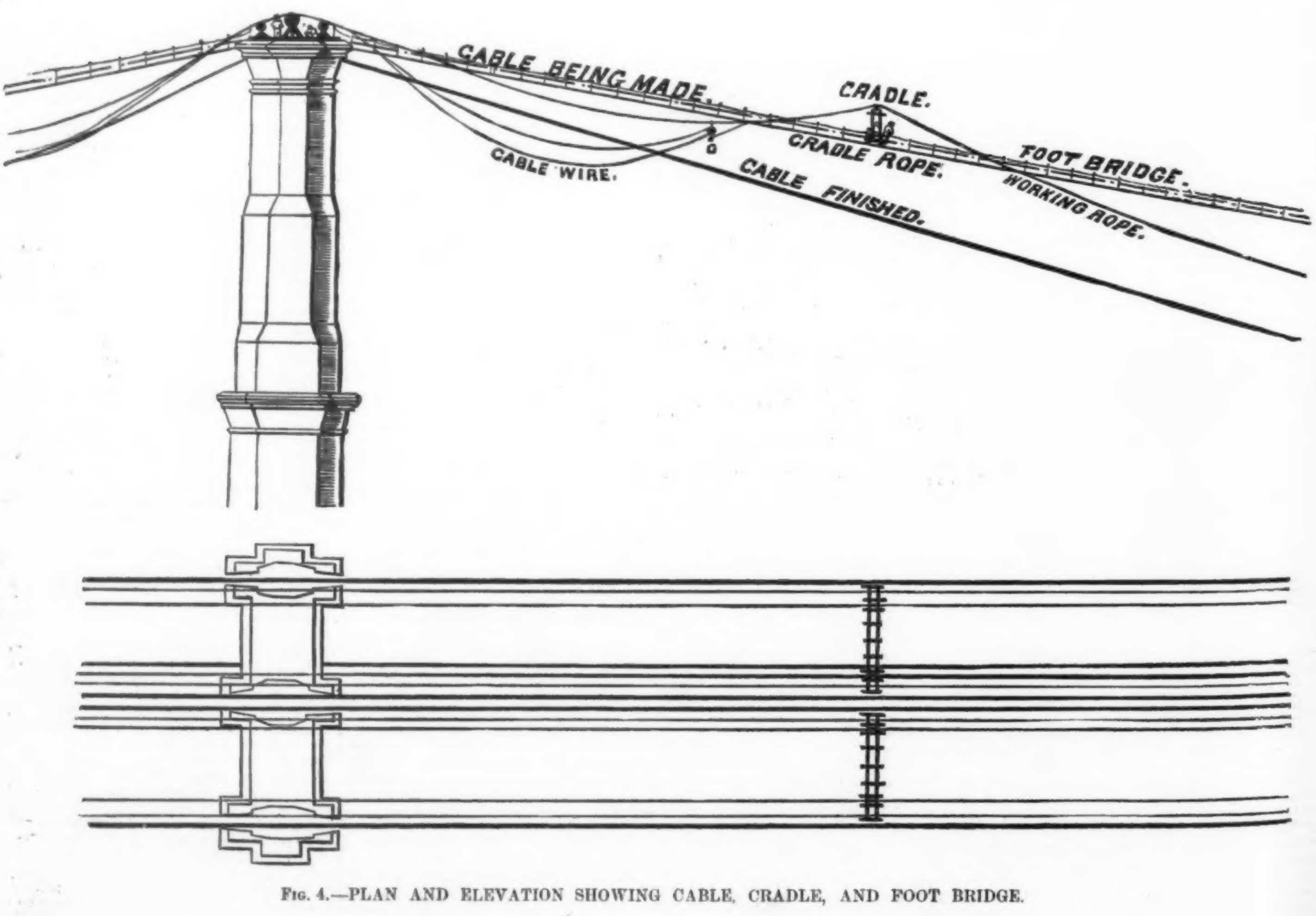


Fig. 4.—PLAN AND ELEVATION SHOWING CABLE, CRADLE, AND FOOT BRIDGE.

THE GREAT SUSPENSION BRIDGE BETWEEN NEW YORK AND BROOKLYN.

THE EAST RIVER SUSPENSION BRIDGE.

CABLE MAKING.

THE East River bridge may be said, at the present moment, to be in a state of preparation for the commencement of operations on the first part of the third stage of its erection, the first being the sinking of the subfluvial foundations and those of the anchorages; the second, the building of the piers and anchorages; and the third, the construction of the superstructure. It will be remembered by our readers that this bridge, which spans the East River from New York to Brooklyn, has a central span from pier to pier of 1595 feet 6 inches, and half spans of 930 feet each from the piers to the anchorages. The towers are 270 feet in height above the water-line, and the centre of the roadway when suspended will be 135 feet above mean tide-water, allowing clear passage to all vessels of less than 1000 tons, those of greater tonnage being obliged to lower their top-gallant masts. When finished, the bridge and approaches will have the immense total length of 5989 feet, or nearly one and one eighth miles. The towers rest on timber foundations about 78 feet below high water, and at the water-line are 141 feet broad and 59 feet thick. By referring to the SUPPLEMENT, Vol. 1, No. 19, the reader will find detailed drawings, an elevation and section of the Brooklyn tower, together with a full description of both towers of the bridge; and in Vol. 34, No. 2, of the SCIENTIFIC AMERICAN, is given a careful description of the building of the New York anchorage, together with a perspective drawing of the anchorage, a section showing the disposition of the anchor plates and chains, and a drawing of an anchor plate. The Brooklyn tower was commenced in the summer of 1870 and the New York tower in 1872. Both are now finished as far as possible before the making and placing in position of the cables.

The making of the cables, from which the roadway is to be suspended, belongs to the third stage of the erection of the bridge, though it possesses such a distinctive interest that it merits being considered as a separate and intermediate stage between the building of the masonry and the suspension of the roadway.

The main cables, of which there are to be four, will each be sixteen inches in diameter, having a tensile strength of 100,000 lbs. per square inch of cross section, and composed of 6289 wires of chrome steel, $\frac{165}{1000}$, or, say, $\frac{3}{16}$ in. in diameter, No. 6 gauge, divided into nineteen strands of 331 wires each. These strands are to be constructed separately, and when finished to be made into the main cable. The cables are to be constructed in mid air, not far from the position they will occupy when ready for the wire-rope suspenders which support the roadway.

The apparatus used in the construction of the cables necessitates the use of five distinct sets of galvanized chrome steel wire ropes. According to the specifications, they are to be as follows: First, four working ropes (for pulling over the cable wires), afterwards spliced into two continuous ones, and passing at each anchorage around sets of tension wheels. These ropes are $\frac{3}{4}$ in. in diameter; have a length of 3800 feet each, and a breaking strength of not less than 18 tons; weigh $\frac{7}{8}$ lb. per foot, making a total weight for all four ropes of 13,300 lbs.; are composed of six strands seven No. 14 wires each, laid around a central core of tarred hemp, and have a lay of about one turn in $6\frac{1}{4}$ inches. Second, two "carrier" ropes (temporary ropes used for carrying over the heavier of the ropes required for the cable-making apparatus), being respectively $1\frac{3}{4}$ and $1\frac{1}{2}$ in. in diameter, having lengths of 3716 feet each, breaking strengths of not less than 108 and 50 tons, weighing 3 lbs. per foot, and having total weights of 20.034 and 9275 lbs., composed of six strands around a wire centre, each strand containing seven wires, and having a lay of about one turn in 9 inches. Third, three "cradle" ropes (to support the wooden "cradles" used as stations by the workmen adjusting the wires), three only being necessary, as one of the foot-bridge ropes serves also as a cradle rope, having a diameter of $2\frac{1}{4}$ in., lengths of 3625 feet, breaking strengths of not less than 180 tons, weighing 9 lbs. per foot, total weights 32,625 lbs. each; having six outer strands with nineteen wires each around a centre, the central strand being the same as the outer ones, and a lay of not less than one turn in $14\frac{1}{2}$ in. nor more than one in $15\frac{1}{2}$ in. These cradle ropes will be afterwards used as under-floor stays. Fourth, two "foot-bridge" ropes, scant $2\frac{1}{4}$ in. in diameter, one 3625 feet and the other 3688 feet long; having breaking strengths of not less than 240 tons, weighing 12 lbs. per foot, total weights 45,312 and 46,100 lbs.; composed of six strands laid around a central core, the outside strands containing nineteen wires each, the core being a regular laid rope composed of six strands and a core, each containing seven wires, and the lay of both core and outside strands being the same, not less than one turn in $17\frac{1}{2}$ inches nor more than one turn in $18\frac{1}{2}$ inches. Fifth, four "pendulum" ropes (for separating the strands as they are made), having diameters of $1\frac{1}{8}$ in. each; being 3700 feet long, weighing $\frac{3}{4}$ lb. per foot, making 2775 lbs. weight each; composed of seven No. 15 wires in each strand, with a wire centre, made in the same way as the carrier ropes, and a lay of one turn in $6\frac{1}{4}$ inches. These comprise all the steel ropes necessary. They are required to be of the best quality of hardened and tempered "crucible cast-steel" wire, wires made by the Bessemer, Siemens-Martin or open-hearth processes not coming within the limits of the contract. All the wire is required to have a breaking strength at the rate of 160,000 lbs. per square inch of cross section. When tested they must stretch at least two per cent, and must have a limit of elasticity of not less than $\frac{4}{5}$ of the breaking strength. For example, a sample of wire stretched up to $\frac{4}{5}$ of its breaking strength must recover itself without any appreciable permanent set. The tests are made after the wire is galvanized. As these ropes are suspended with a very slight deflection, the strain upon them is very great, arising as much from their own weight as from the load placed upon them. An increase in the size of the ropes would increase but slightly the margin of safety, and, therefore, safety depends upon quality of wire used.

For the foot bridge, two galvanized iron hand-rail ropes will be used, composed of seven wires to the strand, No. 17 gauge, having a tarred manilla core; each rope will be 3300 feet long. The under-floor foot-bridge guys will also be of galvanized iron, $\frac{1}{16}$ of an inch, composed of six strands around a hemp centre, and having an aggregate length of 10,868 feet. Each strand is required to be composed of seven wires No. 15 gauge, galvanized, and made of the best charcoal iron. The suspender chords are required to weigh 9 lbs. per foot, to consist of one strand of seven No. 14 galvanized charcoal wires, and to have an aggregate length of 8000 feet.

METHOD OF MAKING THE CABLES.

On the top of the Brooklyn anchorage is stationed most of the machinery to be used in the making of the cables. It consists of two sets of identical apparatus, a description of one of which will answer for both. Fig. 1 is an elevation of the Brooklyn anchorage pier. Fig. 2, plan view of the top thereof. Fig. 3, view of the cable mechanism as arranged on the top of the anchorage pier, with the bridge pier in the distance. Fig. 4, plan and elevation showing the arrangement of the cables and foot bridge. The running or working ropes pass around a system of four grooved tension wheels, one large and three small, working in a plane parallel to that of the top of the anchorage. Taking in the principal drawing (Fig. 3), the apparatus on the right hand, looking towards New York, the rope (A) coming from New York, by way of the towers, passes first round the small wheel (b), then round the larger wheel (a), whence it passes back round the middle smaller wheel (c), returning in an opposite direction to the principal wheel, partly around which it again circles, and then passing around the third small wheel (d) returns towards New York. In passing over the towers the working ropes pass, coming and going, over sets of grooved cast-iron wheels set upright and revolving between large timbers bolted together and extending across the towers. The large grooved wheel (a) has a diameter of 11 ft. 6 in., and the three smaller ones have diameters of 4 ft. 3 in. each. The base of a triangle drawn through the centres of the wheels (a), (b), (c) and (d) would be 23 ft. 6 in. in length. Of the wheels on the towers, the centre one of each set has a diameter of 3 ft., and the two at the ends of 1 ft. each.

The working ropes passing over the cradles run on small grooved wheels set on a frame, as at (K).

The "cradle" ropes (E) and (D), (E) being a foot-bridge rope serving also as a cradle rope, pass 27 feet apart from the Brooklyn anchorage over both towers, resting simply on blocks, to the New York anchorage, where they are again secured. These ropes are to support the "cradles" as at (I), of which there are to be ten in all, 47 ft. long by 4 ft. wide, disposed on the cradle ropes as follows: one on each of the two sets of cradle ropes between the towers and anchorages on both sides of the river, and three on each set of cradle ropes on the central bay, two in the middle and two on each quarter, between the towers. The "cradles," as they are termed, are long, narrow, stationary platforms of wood, resembling nothing more than the "bridge" on an ocean steamer, and are for the use of the workmen regulating the adjustment of the cable wires in their proper positions, preparatory to the strand formation. The cradles, as mentioned above, serve as supports for running wheels over which pass the working ropes, carrying over the cradle wires as shown in the drawing. The working ropes are run by a 20 horse-power engine stationed at the foot of the anchorage, the driving belt (f) of which is geared on to a large spur-wheel (e), to which the principal wheel of the system is fastened. A foot bridge (F), for the use of the workmen passing to and fro, is to be constructed, $3\frac{1}{2}$ ft. in width, and supported on two foot-bridge ropes (C) and (E). The railing ropes of the foot-bridge will be 3 ft. above the floor.—The "cradle" and "foot-bridge" ropes in their final positions it is calculated will have a deflection of 73 ft. 3 in. below the crown of the masonry of the towers; a central span of 1572 ft., equivalent curve on the land sides, half span of 1313 ft. 3 in., counted 12 ft. from the centre of the tower, and a deflection of 211 ft. 1 in. The foot bridge will be guarded against lateral strain by under-floor guys attached to the towers and also between the towers and the anchorages to points on the ground beneath. To prevent confusion in the drawing, these latter are not shown. The wheels receiving the working ropes on the New York anchorage are similar to those on the Brooklyn one.

On the Brooklyn anchorage, back of each system of wheels and cover of large sheds, are situated four sets of drums, one set for each cable to be made, consisting in all of thirty-two drums, or eight to each cable. These drums (see L L L L on the principal drawing) are for holding the cable wire, are about 9 ft. in diameter by 2 ft. broad, and furnished on one side with spokes, so that the paying out of the wire can be properly regulated by men stationed at the drums for that purpose.

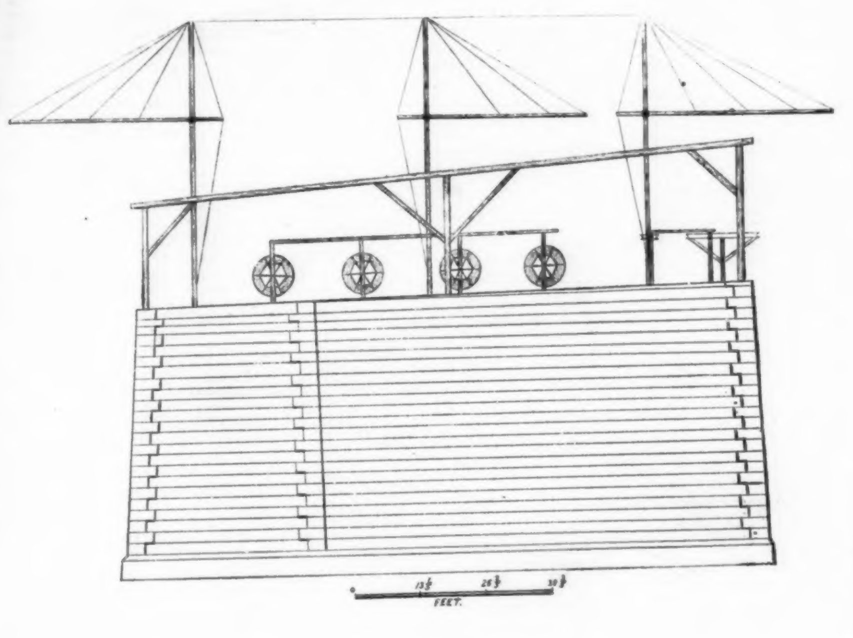


FIG. 1.—ELEVATION OF BROOKLYN ANCHORAGE.

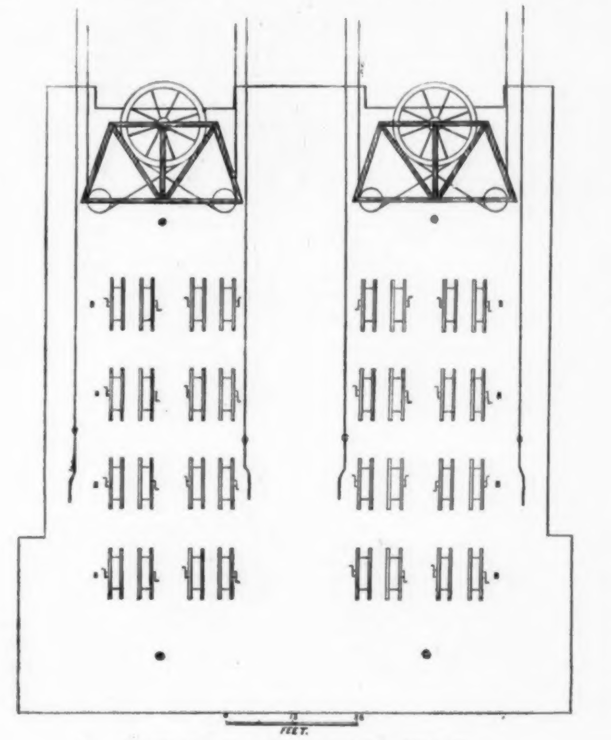


FIG. 2.—PLAN OF TOP OF ANCHORAGE.

THE GREAT SUSPENSION BRIDGE BETWEEN NEW YORK AND BROOKLYN.

On the 12th of August the first of the working ropes was wound upon a drum placed at the foot of the water face of the Brooklyn tower. This being finished, the free end was fastened to a rope let down from the tower, the rope then being drawn over the tower and from thence to the anchorage, where it was temporarily made fast. On the 14th of August the drum was placed on one of the stone barges, and all being ready, the barge was towed across the river by two steam tugs, the steel rope being meanwhile paid off from the drum, sinking to the bottom of the river. In eight minutes the foot of the New York tower was reached, the remainder of the rope was taken off the drum, and coiled on the pier in such a way as to leave the end of the rope on top of the coil. A hempen rope was then lowered from the top of the New York tower, and made fast to the steel one, which was then by this means raised to the top of the tower and carried over, resting on the three wheels placed there for its reception. It was then fastened to a drum worked by a fifteen horse-power engine at a rate of fifty revolutions per minute, and in two minutes was drawn over the tower. As the rope was now to be raised from the bottom of the river to its permanent position at an elevation of some 200 ft. above high tide, a steam tug warned all vessels away. On account of the immense up and down river traffic it was fully an hour and a quarter before the river was clear enough to allow of the rope being drawn up from the bottom. The drum was now attached to a thirty horse-power engine, working it at the rate of 150 revolutions per minute. In two and a half minutes the last of the wire left the water in the middle of the river, and in five minutes was swinging from New York to Brooklyn. Later in the afternoon a second wire was carried over, and now the two working ropes and one cradle rope are in their places.

The principal cables used for the cable-making apparatus are lashed to a carrier rope and so drawn over, a man drawn over in a "boatswain's chair" suspended from the working ropes afterwards cutting the lashings, and freeing the rope from its carrier. When every thing is ready for the com-

mencement of operations on the rope making, an end of wire is fastened to the end of one of the anchor chains, and placed round what is known as a "carrier sheaf" (G) in the first and third drawings, which consists of a small spoked and grooved wheel with a weight attached, which, when the wire is in position, is fastened on to the working rope, and carries the doubled cable wire over, as shown in the large drawing. At each cradle the sheaf is lifted over the running wheel, which operation is also repeated at the top of the towers. On the arrival of the wire at the New York side, it is taken off the sheaf and made fast. Two sheafs are used, so that one will be coming back empty while the other is going over with the wire. When over, the wires are adjusted in the proper positions by the men stationed on the cradles, who, by means of flags and other signals, instruct the men at the drums whether to pay out more or to wind in, as also the men on the towers. A full description of the various operations connected with the cable making will be given hereafter, as the work progresses.

In the drawing Fig. 4, a side view of one of the towers is seen, showing the cradle and working ropes, the line cable in process of being made, a cradle and part of the foot bridge to be used by the cradle men in going to and coming from their work. The cable is also shown in the position it will occupy when finished. The ground plan gives the position of the different ropes, including those of the foot bridge, with respect to each other and the tower. When it is said that after every thing is ready the making of the cables will occupy the greater part of two years, it can be seen what a gigantic operation it will be.

For information and facilities the writer has to acknowledge his obligations to Mr. Hildebrandt and Colonel Payne, assistant engineers of the Bridge Company.

THE WESTERN UNION TELEGRAPH COMPANY.

(*From the Annual Report of the President, William Orton, for the fiscal year ended June 30, 1876.*)

THE gross receipts for the year, from all sources, were \$10,034,983.66; the gross expenses, \$6,635,473.69; and the net earnings, \$3,399,509.97.

At the close of the year ended June 30, 1876, there were in operation 73,532 miles of line, 183,832 miles of wire, and 7072 offices.

There were in use on the lines of the company, at the close of the fiscal year, 8437 sets of instruments for reading by sound, 18 printing instruments, 1729 recording instruments, 11,186 relay magnets, 11,365 transmitting keys, 253 repeaters, 4328 switch-boards, 4133 cut-offs, 3201 lightning arresters, and 93,819 cells of battery.

The number of messages transmitted during the year ended June 30, 1876, was 18,729,567—being an increase of 1,575,857, or 9.2 per cent. This includes press reports sent, reduced to messages on the basis of 30 words to each message. The average tolls collected upon each message in the year ended June 30, 1875, was 54 cents, the average cost of transmission 35 cents, and the average profit per message 19 cents; while for the year ended June 30 last, the average tolls was 50.9 cents, average cost 38.5 cents, and average profit 17.4 cents.

The capital stock of the company is \$41,073,410, of which the company owns and has in the treasury \$7,272,235.

The bonded debt of the company is \$6,332,119.

PNEUMATIC TUBES.

During the past year the central office in New York has been connected with the branch offices at No. 14 Broad street, No. 134 Pearl street, and the Cotton Exchange, by pneumatic tubes. The tubes are made of brass, each $2\frac{1}{4}$ inches internal diameter, and $\frac{1}{8}$ of an inch thick, and are laid under the pavements in the streets at a depth of three feet.

Messages are sent from the central office to the several branch offices by compressed air, and from the branch offices to the central office by atmospheric pressure or vacuum. The motive power is furnished by a 50 horse-power duplex engine, situated in the basement of the central office, which operates two double-acting air pumps communicating with the compressed and vacuum mains terminating in the operating room. These are connected to the tubes extending under the streets by means of double sluice valves, which are so constructed that carriers containing messages may be sent through the tubes in either direction by turning a cock connected with the compressed or exhaust air mains.

With the usual pressure employed—six pounds to the square inch—the time occupied in transmitting a box or carrier containing messages between the central office, corner of Broadway and Dey street, to the office at No. 14 Broad street (700 yards), is about 40 seconds; and between the central office and the offices at No. 134 Pearl street and the Cotton Exchange (900 and 1100 yards each), about 1 minute and 5 seconds and 1 minute and 20 seconds, respectively.

The operation of the pneumatic tubes is very satisfactory, resulting in a material saving both in time and money.

The total cost of the system is less than \$30,000, and about one half of the outlay will be saved annually, to say nothing of the saving in time, by the decreased cost of performing the service by pneumatic tubes between these stations, as compared with the former cost by wire.

There are several other offices in the city where the traffic is large enough to warrant their connection by pneumatic tubes with the central office, and it is probable that the system will be extended to some of them after its value has been more fully ascertained.

GENERAL REVIEW.

On the first day of July, 1866, ten years ago, the organization of the present Western Union Company was completed by the consolidation of the leading telegraph companies in the United States. During the period that has since elapsed, the company has increased the extent of its lines from 37,380 to 73,532 miles; its wires from 75,686 to 183,832 miles; its offices from 2250 to 7072, and the number of messages annually transmitted from 5,879,282 to 18,729,567, while at the same time it has reduced the average tolls per message from \$1.05 to 50.9 cents, and the average cost of performing the service from 67 cents to 33.5 cents per message.

Thus it will be seen that the mileage of line has been increased 96 per cent, the mileage of wire 142 per cent, the number of offices 214 per cent, the number of messages annually transmitted 219 per cent, and the tolls reduced 52 per cent.

During this period of ten years, in which the company's wires, offices, and traffic have doubled and trebled in number and extent, the capital stock outstanding has been reduced from \$41,073,410 to \$33,801,175—the difference, \$7,272,235, being in the treasury, and other property acquired representing an aggregate value of nearly \$12,000,000.

These results will compare favorably with those of any other corporation carrying on a business of like public importance in this country during the same time.

For the year ended December 31, 1874—the last year for which complete official returns have been received—the total number of messages transmitted in Europe was 58,141,934; the total receipts \$19,980,275, and the expenditures \$22,872,934.

The average tolls per message, as will appear from these figures, was 34.3 cents, while the average cost of performing the service was 39.3 cents, the excess of expenditures over receipts being \$2,892,656.

From this it will be seen that the average cost of transmitting telegrams in Europe is 5.8 cents more than the average cost of transmission by this company.

These gratifying results are mainly due to these causes: First, to the extension of lines and the decided improvements which have been made in their construction and maintenance; to improvements in apparatus, including the introduction of the duplex, quadruplex, and other new methods of transmission, by which the carrying capacity of the lines and the working capacity of apparatus has been greatly increased; and, secondly, to the unification of the entire system, which is an essential requisite to the proper conduct of a business covering so vast an area and embracing so many and such a variety of details. By the consolidation under one central management, it has been practicable to keep in view at all times the definite purpose of affording the public the best facilities for quick and accurate communication at reasonable and, as far as possible, uniform rates.

PHOSPHOR-BRONZE.

DURING the four or five years that the metallic alloy known as phosphor-bronze has been before the public, it has undergone an infinite number of severe tests, and all have served to establish the extreme value of this compound metal for a great variety of purposes. Great advances have been made in its application, and we now propose to devote a short time to the subject, to show some of the great advantages to be derived from the use of phosphor-bronze for industrial purposes. This, with regard to its comparative value with other metals, will be seen from the following tables:

CAST METAL.	Diminution of Section before Rupture.	Resistance in pounds per square inch.	
		Elastic.	Absolute.
	Per Cent.	Pounds.	Pounds.
Pure Copper	3.30	4.4000	6.975
Ordinary Gun Metal, containing 9 parts Copper, 1 part Tin	3.60	12.800	16.650
Phosphor-Bronze	8.40	23.800	52.625
Phosphor-Bronze	1.50	24.700	46.100
Phosphor-Bronze	33.40	16.100	44.448

DRAWN METAL.		Pulling Stress per square inch.		Twist in 5 inches.		Ultimate Extension
		Wire as drawn.	Annealed	Wire as drawn.	Annealed	
		lbs.	lbs.	lbs.	lbs.	Per Cent.
Various Alloys.	Phosphor-Bronze	102.759	49.351	6.7	89	37.5
	" "	120.957	47.787	22.3	52	34.1
	" "	120.950	53.381	13.0	124	42.4
	" "	139.141	54.111	17.3	58	44.9
	" "	159.515	58.853	13.3	66	46.6
	" "	151.119	64.569	15.8	60	42.8
Copper		63.122	37.002	86.7	96	34.1
Steel		120.976	74.637	22.4	79	10.9
Iron, Galvanized best Charcoal E		65.834	46.160	48.0	87	28.0

N.B.—The Wire used for these experiments was No. 16, Birmingham wire gauge.

Result of the trials made in the Royal Berlin Academy of Industry by order of the Minister of Commerce:

A.—Trials made by repeated pulls.

PHOSPHOR-BRONZE CAST.			ORDINARY BRONZE CAST.		
No. of Bars	Highest pulling stress per square inch.	Number of Pulls before Rupture.	No. of Bars	Highest pulling stress per square inch.	Number of Pulls before Rupture.
	Tons.		1	Tons.	Broke before attaining this stress
1	10	408.350	2	10	
2	$12\frac{1}{2}$	147.850	3	10	4200
3	$7\frac{1}{2}$	3,100.000	4	$7\frac{1}{2}$	6900
B.—Trials by repeated one-sided Bends.					
1	10	862.980	1	10	102.65
2	9	after 4 millions (still unbroken)	2	9	150.000
3	$7\frac{1}{2}$	" 3 " (still unbroken)	3	$7\frac{1}{2}$	837.760
4	6	" 2 " (still unbroken)			

C.—Trials by repeated twists both ways.

A bar of forged phosphor-bronze has resisted without rupture over $2\frac{1}{2}$ million twists at a strain of 12 tons.

The purposes for which it can be used are more numerous than could be readily enumerated. For instance: bearings and various parts of machinery, locomotives and boiler tubes, printing rollers and engraving plates, bell metal, wire and wire rope, bolts, nails and rivets, fire-arms, cannons, tools, tuyères, harness fittings, ornamental castings, etc., are only a few of the uses to which it is now being successfully applied. The great features of phosphor-bronze are that it can be made to any degree of hardness, toughness, or elasticity. According to the wish of the operator, it can be rendered more ductile than copper, as tough as wrought iron, or as hard as steel. It possesses great fluidity, its homogeneity is complete, and its grain is as fine as that of cast steel. It may be controlled with the most perfect ease and accuracy to suit every particular purpose for which it is intended. Another important feature is that its value as a metal is retained indefinitely, for unlike other alloys, it can be remelted as often as may be desired without any appreciable loss or material alteration of its quality, while heavy steel castings, on the other hand, when worn out or broken, are comparatively worthless. The phosphor-bronze alloy made for rolling, drawing, or embossing, will stretch more than copper or any of its ordinary compounds. Plates have been reduced by a single cold rolling to one fifth of their thickness, the edge remaining perfectly sound, and without cracks. Its general adaptability for so many purposes, many of them very diverse in their character, besides many others which will suggest themselves to our readers, point very clearly to the fact that this metallic alloy must necessarily possess the advantages and features claimed for it. Its ductility, fluidity, homogeneity, hardness, toughness, elasticity, strength, compactness, and fine grain, adapt it for all descriptions of work, from pins or pens to the most elaborate and beautiful ornamental castings. The English and Continental press have pronounced very favorably respecting the merits of this alloy; the scientific press generally having during the period the phosphor-bronze has been introduced, given much attention to the subject, showing by results of carefully conducted experiments, which they have from time to time recorded, that the metal has been steadily and surely gaining a firm hold on the various industries for which it is so admirably adapted as a material. The *Times* in a recent article alluding to the trials of Her Majesty's frigate "Shah," says: "The great difficulty which has hitherto been experienced with respect to the 'Shah's' engines has been the crank bearings, which became so heated from the enormous strain to which they were subjected, as to cause the white metal to run. Some idea of these strains may be obtained from the fact that the cylinders, $116\frac{1}{2}$ inches in diameter, are the largest made; that the power developed is required to exceed seven times the nominal horse-power; and that, with a displacement equal to that of many of our second-rate armor-clads, the 'Shah' is expected to be propelled through the water at a rate of speed not less than that of the 'Inconstant,' which has never yet been outstripped by any ship afloat. The eminently gratifying character of the trial may also be, perhaps, best realized if we state that the power indicated during the full-speed runs fell short only by 150 horses of the contract standard, and that with 5 ft. additional length, 2 ft. more beam, a foot deeper in the water, and something like three per cent more of weighted surface, her mean speed on the mile fell short of that of her sister ship—the 'Inconstant'—only to the inappreciable extent of .06 of a knot. So far as speed itself is concerned, the behavior of the 'Shah' has throughout the whole of the trials pretty well justified expectation. She is provided with one of Hirsch's patent two-bladed screws, and it is the singular merit of this propeller that, while it reduces vibration, it also converts the loss usually caused by the centrifugal action of the water into a gain for propulsion. The main effect of the heated bearings has been to prevent the contract power being got out of the engines, and consequently to delay the ships being formally taken over by the Admiralty. On the first trial the power developed was only 6464 horses, and on a subsequent trial the power was increased to 6868.87, the contract being for 7500. The principal cause of the satisfactory results of Thursday is doubtless to be traced to the substitution of phosphor-bronze for the usual brass and white metal, whereby the bearings, though liable to become heated and even to cut, do not fuse and run." From a paper read before the Iron and Steel Institute, by M. J. Maune, we learn that owing to its great resistance and elasticity, phosphor-bronze has the advantage of not becoming crystalline under the action of repeated shocks, as is the case with iron and steel. It is, therefore, eminently adapted for making wire rope, as a core for submarine cables, etc. Phosphor-bronze is readily rolled or beaten out into sheets. In Russia it has been used as a material for cartridge sheathing, and specimens have stood 120 trials without tearing. Sheets of the alloy stand the action of sea-water much better than copper. In a comparative experiment made at Blakenberghe, lasting over a period of six months, between the best English copper and phosphor-bronze, the following results were arrived at:

Thickness of the Sheets = 0.236 in.	Weight before Immersion in Pounds.	Weight after Immersion in Pounds.	Loss of Weight.	
			In lbs.	Per cent
Sheet of Copper	74.4	72.2	2.2	3.015
" "	88.9	86.2	2.7	3.100
Sheet of Phosphor-Bronze	69.5	68.75	0.75	1.123
" " "	114.3	112.97	1.33	1.195

The loss in weight, therefore, due to the oxidizing action of sea-water during the six months' trial, averaged for the English copper 3.058 per cent, while that of phosphor-bronze was but 1.158 per cent. From M. Maune's paper we also learn that it was desirable to ascertain the resistance of the alloy to the chemical action of dilute sulphuric acid. For this purpose, on the 22d of last April, two similar sheets of copper and phosphor-bronze were immersed in acid water of 10 deg. Baumé strength, and at the temperature of the surrounding atmosphere. On the 28th of July it was found that the copper had lost 4.15 per cent, and the phosphor-bronze only 2.3 per cent. Another most important application of phosphor-bronze, and one which has received particular attention, is with regard to bearings, and most excellent results have been obtained. Any one using machinery will readily understand why a material which wears from two to five times better than best gun metal, which is very much less liable to heat than gun metal, and which, when heated, does not cut the journal, has received such general approval, not only by the mills in which it has been in long service, but by some of our large railway companies who have adopted it for locomotives and car brasses. The Royal Carriage Department use phosphor-bronze largely for the sheaves of gun carriages, and the Admiralty specify the metal for bearings, slide-valves, and faces, etc. The valuable uses to which phosphor-bronze can be applied are so various and important, that we are very glad to find that the manufacture of the material, and appliances for casting with it, are becoming firmly established in the country. This is not at all surprising; indeed, it is what must have been looked for from the first moment of its introduction. A metal possessing qualities which so excellently adapt it for such varied applications, could not fail to make its mark on all our great industries, and we feel sure it will go on increasing in popularity and public estimation, entirely superseding in time gun metal, and proving a powerful competitor to iron and steel for all purposes where elasticity, ductility, closeness of grain, homogeneity, toughness, and rigidity are required.—*British Mercantile Gazette.*

LOCOMOTIVE TRACTION.

A CORRESPONDENT calls our attention to an error in the article on 18-inch gauge locomotives, copied from *Engineering*, and printed in SUPPLEMENT No. 44. In calculating the traction the formula $\frac{5\frac{1}{2} \times 6}{15}$ is given, which is incorrect. It should read $\frac{(5\frac{1}{2})^2 \times 6}{15}$, as the traction of a locomotive per pound of effective pressure per square inch of piston is found by multiplying together the *square* of the piston diameter and the length of stroke, and dividing by the diameter of the driving wheel in inches. This correction made, the remainder of the calculation will be found to correspond.

COPPER DEPOSITS OF AMERICA.

DR. T. STERRY HUNT lately made some remarks before the American Institute of Mining Engineers on the copper deposits of America, and particularly of those of Lake Superior. He noticed the early history of the attempts to work the native copper of that region, and the doubts which were at first entertained as to the value and the probable permanence of mines so unlike any others known. The formation consists of sandstone, and conglomerate with great masses of interstratified eruptive rocks and volcanic tufas, the whole forming a series many thousand feet in thickness, to which the name of the Keweenaw group has been given. From the many resemblances between this and the mesozoic sandstone with eruptive traps that occur on the Atlantic slope of the Appalachians, the copper-bearing series of Lake Superior was also referred to the mesozoic period, but the late researches of Pumpelly have confirmed the views of Logan and Whitney, who assigned it a position at the base of the palæozoic column. It rests on the crystalline rocks of Huronian age, and is unconformably overlaid by sandstones which are considered to be lower than the Trenton limestone. The copper occurs in these rocks in great fissures traversing the strata, from which masses of the metal, of many tons in weight, are sometimes extracted; but a more abundant and more constant source of the metal is found in the finely disseminated copper which occurs scattered through certain beds of volcanic tufas and sandstones, as in the Boston and Albany, and Calumet and Hecla Mines, forming the cement of quartziferous porphyries.

Dr. Hunt then gave some account of the mode of mining these deposits, and explained that by careful mechanical treatment, rocks yielding not more than one per cent of metallic coppers can be exploited with advantage. He described the immense yield of copper from the Calumet and Hecla Mine, which furnishes annually about 10,000 tons of ingot copper, the whole product of the region being about 18,000 tons. As regards the theory of the origin of metallic coppers, he gave reasons for regarding them of aqueous and not of igneous origin, that the source of the copper was to be sought in the old crystalline rocks of Huronian age. These contain in many places large amounts of sulphuretted ores, from the oxidation of which soluble copper salts are formed. The chemical processes probably depended on the intervention of organic matter aided by volcanic heat, which caused the precipitation of metallic copper, and the association with it of metallic silver. Allusion was made to the wide dissemination of copper in the mesozoic rocks of the Atlantic slope, from Nova Scotia to Virginia. These also rest upon old crystalline schists containing pyritous copper ores, from which the copper was probably derived. In some few cases, copper is found with these mesozoic rocks in a metallic state.

These deposits are seldom very rich, but are in some cases mined and smelted with advantage. The large deposits of cupriferous pyrites, generally of low grade, in the crystalline rocks of the Appalachians, in various localities from Canada to Alabama, are like the pyritous ores of Spain and Portugal, valuable also as ores of sulphur. They are smelted in Vermont and Tennessee, but the cost of working low-grade ores in regions where mineral fuel is not easily accessible, is so great as to render humid processes more economical. Dr. Hunt terminated his remarks by a brief description of the Hunt & Douglas humid process now used at Ore Knob, in North Carolina, and at Phœnixville, Pa., for the extraction of copper.—*Engineering and Mining Journal.*

HYDRAULIC MINING AT DUTCH FLAT.

THE method of hydraulic mining is briefly this: From some lofty point a head of water is let on through iron pipes of varying diameter, and is projected in a thin stream against the bottom of a hill of gravel known to contain gold. The earth falls in loosened masses, and is washed into channels which lead to sluice-boxes. A sluice-box is a narrow trough made of planks and provided with a false bottom. Over the upper surface the current of earth and water passes, the finer portions of the gravel, together with what gold there may be, falling through apertures upon the real bottom below. Here at intervals are cross-pieces a few inches high, in whose angles quicksilver is placed. The particles of gold, great and small, draw to this, while the worthless earth is washed on and out of the way. These sluice-boxes are watched night and day, and are "cleaned up," that is, the amalgam is taken out at intervals, which vary from ten days to three months or more, just as the earth is more or less rich in metal.

The pipes which convey the water are made of thin iron, hardly thicker than box cardboard, and vary from some forty inches to fifteen in diameter. They are smooth, round, and black as jet. They are led across depressions in the ground upon trestles, and where the surface is favorable, they are laid upon sleepers like the tracks of a railway. They are often miles in length, and though their general tendency is downward, yet they make many rises and turns. The pipe near by you disappears a short distance off, behind a low hillock; it comes into view again two or three rods farther on; then it is lost for a quarter of a mile, and you see it climbing a hill like a serpent, bending itself over the crest, and vanishing once more; then, perhaps, you may see it in the faint distance curving like a hair-line, still doing its tremendous duty, yet with so little suggestion of the great power contained within it.

You bend down and apply your ear to a little orifice you find upon the upper side of one of these pipes, and you hear the furious rush of the water; at the same time your hat is blown from your head by a back-handed current of air that bursts from its imprisonment within the tube. A mile farther on you may be startled to hear a loud continuous roaring and hissing. You look about and discover another of these pipes surcharged with water, which seeks to escape from every joint and pin-hole in the entire length. The ground is wet beneath it, little pools forming here and there, while jets of spray shoot in all directions, catching the rays of the sun most delicately.

The water issues from the pipes, at the place where the mining is carried on, with astonishing force. Lofty hills, broad plains, and long cliffs are washed away, and their ruin completed by nothing else than a shaft of water a few inches in diameter, thrown violently and persistently against them. Nothing can withstand it. Trees, gnarled stumps, rocks of prodigious size, are whirled hither and thither, like bubbles in the wind, and the softer earth is melted like frost before the fire. A stream having a fall of two hundred feet, and being forced through a two-inch pipe at its head, is a weapon of appalling force. It will cut into banks of packed clay that a pick-axe cannot penetrate, and tear out of their fastnesses rocks half as large as a railway car, and whirl them about as easily as a garden jet does its silver globe. Were it to strike a man it would literally tear him to pieces; not stun him, or simply kill him with the shock and the suffocation, but it would rend him limb from limb, as an explosion would.—ALBERT F. WHEELER, in *Appletons' Journal.*

COMBINED SPRING MOTORS.

By CHARLES J. SCHUMACHER, Portland, Me.

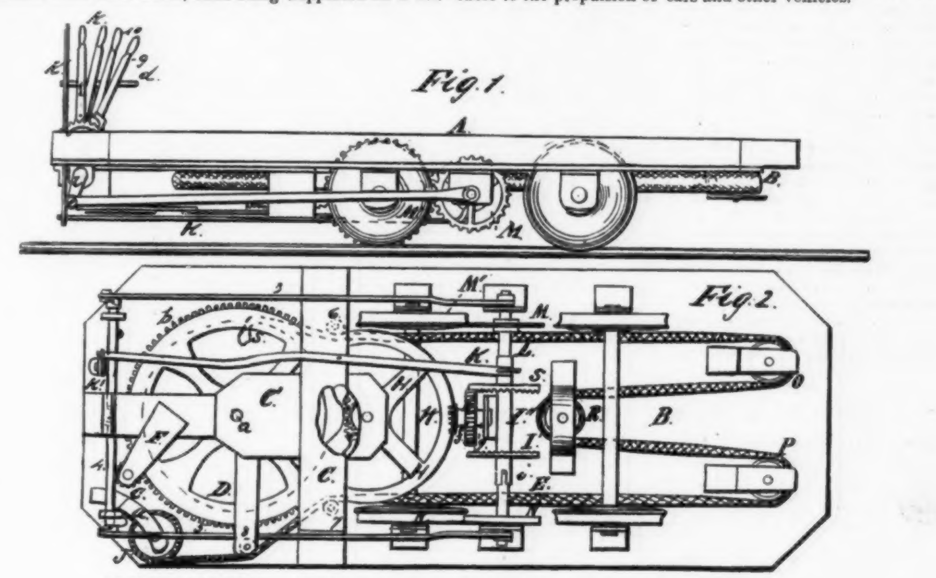
A, THE driving-shaft; B, crank by which the machine is wound up. C and D bevel or mitre gears, the former being on the end of the shaft A, and the latter is connected with the spring E. In this example of my invention I employ four springs, but any additional number may be used. F, stationary spindles or rods confined by the heads G G′ of the machine. H, bed-plate to which the heads are attached. The driving-shaft A is connected with the head G′. The four springs are parallel with each other, each being supported on a rod or spindle, as represented. J J′ are spur-wheels on the ends of the spindles next the head G. K K are spur-wheels on the ends of the two lower wheels, next the head G′, which mesh together. L is a large spur-wheel on the end of the upper spindle F, connected with the spring Q. The springs are securely attached to the wheels by means of solder, and freely turn on their respective spindles. N represents short cylinders, or rollers which are slipped loosely on to the cylinders, around which rollers the springs are arranged. These rollers revolve freely on the spindles.

The power is first imparted to the spring E by means of the bevel-gears C and D, the latter being connected with the spring E. From the spring E the power is imparted to the spring O directly beneath, by means of the spur-wheels J J′. At the other end of the machine the spur-wheels K K mesh together, which conveys the power to the spring P, and from the spring P it is imparted to the upper spring Q by the wheels at the opposite end of the machine. The upper spring Q carries the power to the large spur-wheel L.

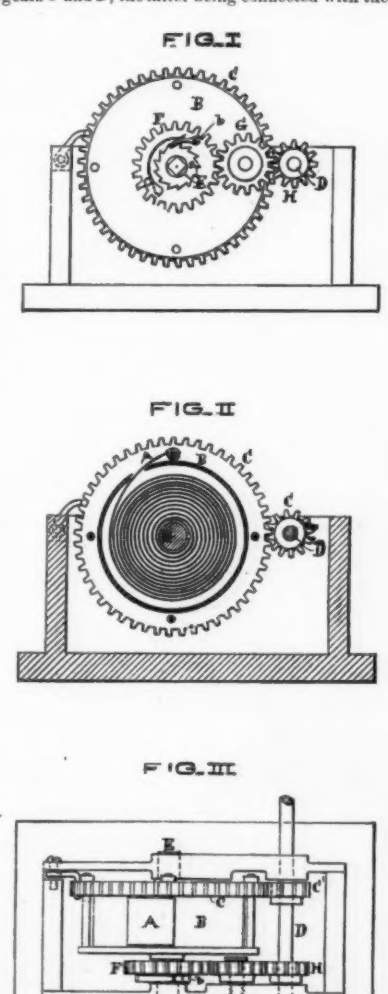
In applying this piece of mechanism to a sewing-machine or similar piece of machinery, the large wheel L is geared with or attached to such machine.

S is a ratchet-wheel on the back of the bevel-wheel D, and T is a pawl which engages therewith, attached to the head G′, by means of which the strain or torsion which has been imparted to the spring and conveyed from one to the other, is retained as long as may be desired.

The power thus stored up can be renewed while the sewing-machine is running, so that no time need be lost in winding up or supplying the power. The invention is readily applicable to the propulsion of cars and other vehicles.



SPRING MOTORS.—STREET CAR PROPELLED BY RUBBER SPRINGS.



SCHUMACHER'S SPRING MOTOR.

SPRING MOTORS.

PROPELLING STREET-CARS BY RUBBER SPRINGS.

By JONES AND TERFLOTH, New Orleans, La.

THIS is a mechanical arrangement through the agency of which a man on a car can, without other aid, develop the tensile force of a powerful elastic-gum spring sufficiently to start the car from a state of rest, and then, after it is started, to bring into use the momentum of the car, whenever it is stopped or checked in its speed, to propel or drive the same on for an indefinite time or distance by throwing it (the momentum), or, more accurately, the force which it develops, into the spring, and storing it therein for the continuous propulsion of the car.

The man on the car who is assigned the duty winds up the spring E on the power-pulley D, by turning by hand the circular crank *d*. The rotation of the parts and their relative dimensions, it will be observed, make this an easy task, because of the multiplied power which they develop. As soon as this is done the car is ready to start, but if it is heavily laden, it may be necessary to reverse the motion of the crank *d* for a quarter or half turn, in order to assist the tensile force of the spring E in overcoming the inertia of the car, but as a general thing this will not be necessary. If the car is not ready to start the moment the spring is wound up, a pawl and ratchet on the floor of the car, which are not shown on the drawing, afford the means of holding it still. When the car is to be stopped, the cog-wheel M is thrown out of connection with the car-wheel M′ by a movement of the lever 1, and held out of position by the lever-pawl and ratchet *j*, while the friction-pulley N is thrown in contact with the perimeter or tread of the car-wheel N′, and maintained in contact therewith by means of the lever-pawl 10 and a ratchet exactly similar to *j*. The lever K′ is now moved, in order to throw the wheel I out of and the wheel I′ into connection with the pinion *h*, which reverses the direction of the rotation of the shaft L, and hence also of the friction-pulley N, and makes it act as a brake, while at the same time reversing the motion of all the parts, and hence winding up the spring E on the power-pulley D, by diverting the force developed by the momentum of the car, which it is overcoming, and throwing it into the spring E. The moment the car stops the operator seizes the circular crank *d*, and winds up what has not been taken up of the spring, before the car has ceased its motion, or so much of the same as may be necessary to start and run the car until another stop is made, when the same operation we have just described is repeated, and so on indefinitely. By having a spring, which may be easily done, two or three hundred feet long, a car may be run a mile and a half or two miles without taking up any of the spring which has left the power-pulley D, but it may be taken up, as we have shown, at much shorter intervals, or whenever, indeed, it becomes necessary to do it.

In the practice of our invention we may dispense with the wheel H, and bring the pinion *f* in direct connection with the power-pulley D, or we may gear said pinion into another (by bevelling both) that is placed on the car-axle W, or we may modify in other respects the arrangement of the parts, without at all affecting the general characteristics or the mode of operation of our invention.

Our invention affords a simple, and, as we have demonstrated by experiment, a most effective means for propelling cars, which is far cheaper than steam, pneumatic, or any other engines yet employed for such purpose, and their horses or mules to pull them along.

NATURAL GAS WELLS.

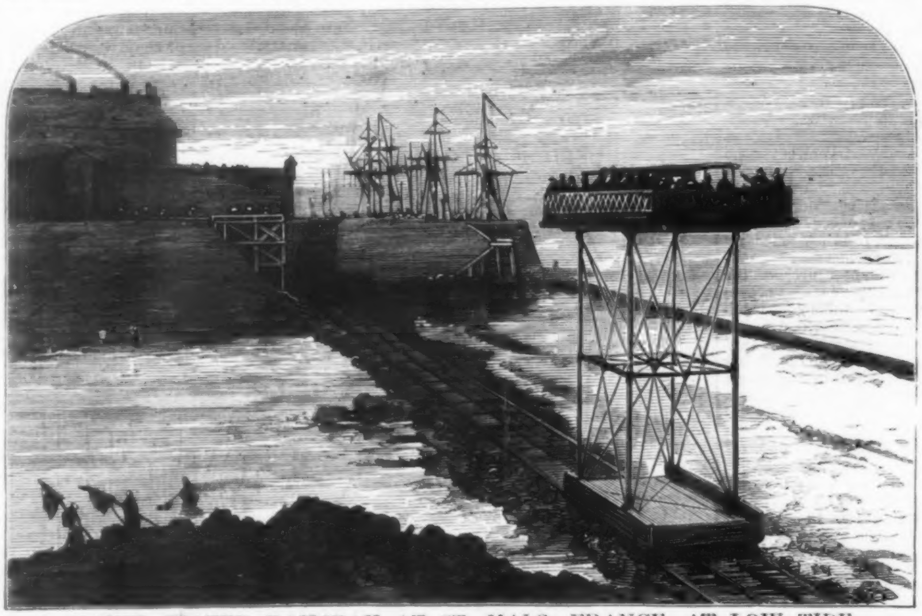
THERE are now three gas-producing wells at Beaver Falls, Pa., one of which has been in operation over seventeen years. Two of the wells are nearly 1100 feet in depth, one having been reamed out, and is said to produce about 100,000 feet per day, which is utilized in the cutlery works, except what is used in the gas-lighting works, where it supplies about 60 per cent of what is used. The other well is to be bored out to eight inches. The third well is recently bored and struck a good vein of gas at 500 feet. This well is to be cased twelve inches, with a small tube inside to continue the boring to a greater depth, while the present product of gas, which is much greater than the other wells, can be utilized.

WATER RAILWAYS.

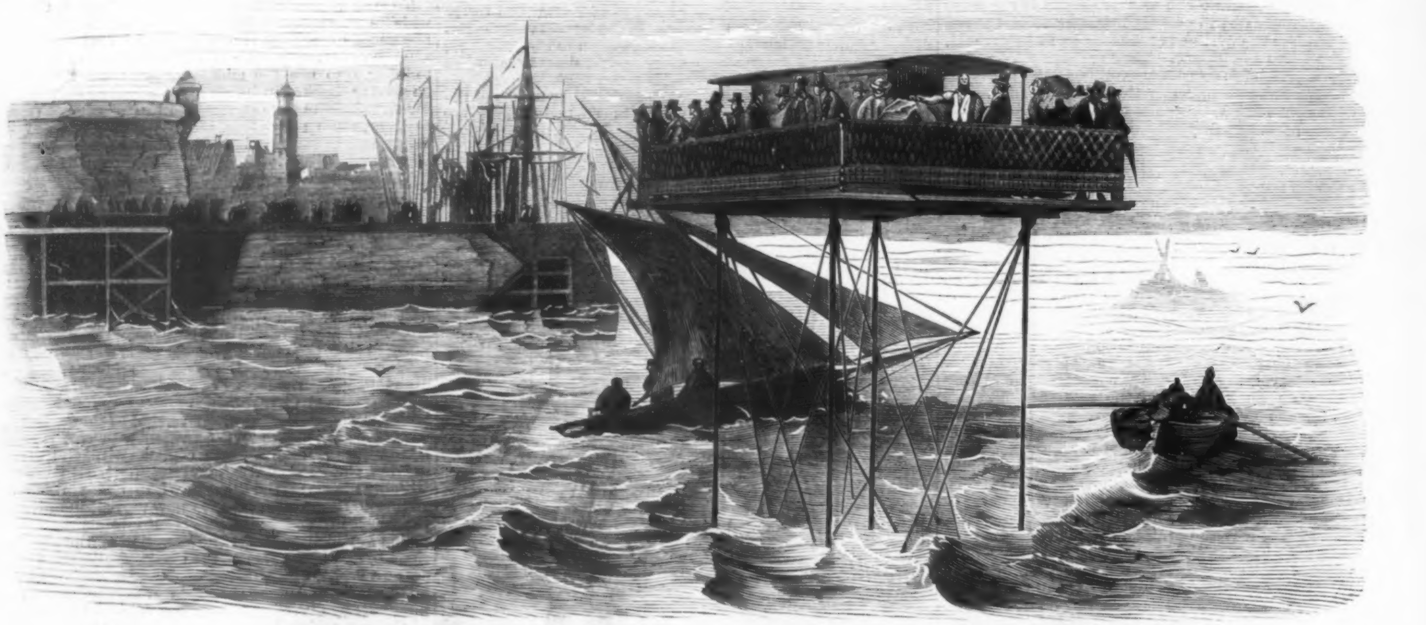
AMONG the successful substitutes for bridges and tunnels for the conveyance of passengers across rivers and water channels, the plan of M. Leroyer, which has for several years past been in successful operation at St. Malo, France, deserves especial notice. We give herewith two illustrations thereof.

The towns of St. Servan and St. Malo, in France, are situated on either side of the river Ronce, or, more strictly, of the arm of the sea into which that river empties. The tide is here subject to great fluctuations, retreating so that the bed of the estuary may be crossed on foot, and again rising to a height of several yards. The mode of crossing the stream, until the construction of the curious railway represented in our engraving, consisted in taking a wide *détour* to a point where an ordinary bridge spanned the river, or else in using boats. To avoid such inconvenience as we have referred to, M. Leroyer, town surveyor of St. Malo and architect to St. Servan, designed and had constructed the railway we illustrate. It consists of a platform supported on wheels, which run on rails laid on the bottom of the estuary. The platform is supplied with accommodation for horses and vehicles at either side, and two classes are provided for passengers, the fares being one and two cents respectively. The platform stands level with the quay at each side, so that nothing is more easy than access to it; and, as our illustrations (from *L'Illustration*) show, it is worked at all states of the tide with perfect safety. One of the engravings represents the car travelling on its ways at low tide, and the other, crossing the river when the water is high.

This railway appears to be exceedingly popular with the inhabitants of St. Malo and St. Servan. It is novel in design, and reflects no small credit on M. Leroyer.



NOVEL WATER RAILWAY AT ST. MALO, FRANCE, AT LOW TIDE.



NOVEL WATER RAILWAY AT ST. MALO, FRANCE, AT HIGH TIDE.

Mons. A. Mottier, of Paris, has designed a still more extensive adaptation of M. Leroyer's plan, to wit, the construction of a road-bed on this system, across the bed of the British Channel, between England and France. We give herewith two figures of the gigantic locomotive that he proposes to employ, with the following particulars:

The bottom of the English Channel is comparatively level; the depth of water about 130 ft. The line proposed is from Sangatte to Deal. It is proposed to raise a causeway of some 33 ft. in height, and 13 ft. in width. On this it is proposed to run a vehicle 330 ft. in length, 125 ft. wide and 125 ft. high, and composed of a pontoon at the base, and a platform above the water, united by suitable framing; the bulk and weight so calculated as to throw no weight on the wheels, which are to be 80 ft. in diameter.

The platform is to be large enough to take an entire railway train on board. The machine is to be propelled by an engine located on the platform, which by means of a chain belt operates a drum, over which winds a chain that lies upon the roadway; being much the same manner that the Belgian canal boats are propelled.

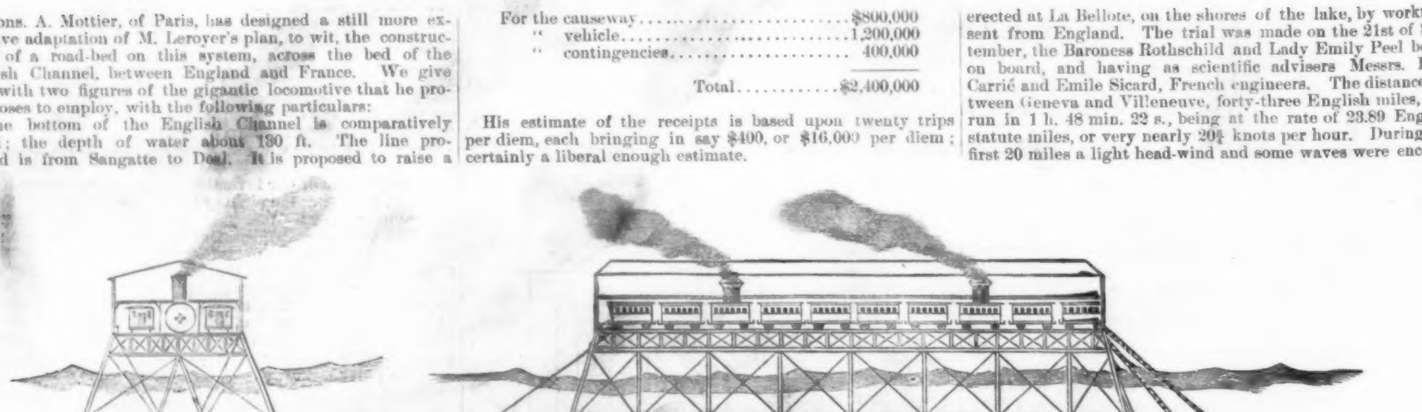
M. Mottier makes the following estimate of the expense:

For the causeway	$800,000
" vehicle	1,200,000
" contingencies	400,000
Total	$2,400,000

His estimate of the receipts is based upon twenty trips per diem, each bringing in say $400, or $16,000 per diem; certainly a liberal enough estimate.

THE FASTEST STEAM YACHT IN THE WORLD.

CONSIDERABLE interest has lately been excited at Geneva by the trial of a new steam yacht, built for the Baroness Adolphe de Rothschild. This vessel, although only 91 feet long by 13½ feet beam, just large enough to contain the accommodation for a day's comfortable cruising on the lake, has attained and kept up a speed greater than that of any ocean steamer afloat, and only equalled, perhaps, by some of the largest American river steamers. The Gitana is rigged as a fore-and-aft schooner, and is built of steel. The accommodation on board the Gitana consists of a large saloon, pantry, and dressing-room forward, and a galley cabin for the crew and store room aft of the engines. The engines are compound direct-acting, fitted with an injection condenser, and with a view to reducing vibration as much as possible were made with three cylinders acting on cranks set 120° apart. The high-pressure cylinder is 13½ inches in diameter by 16 inches stroke, and the two low-pressure cylinders are each 15 inches in diameter by 16 inches stroke. The boiler is of the locomotive type, of Bessemer steel, with a copper fire box and brass tubes. The speed guaranteed was eighteen English statute miles per hour in a run of two hours' duration—that is, thirty-six English statute miles in two hours, subject, in the event of failure, to the yacht being thrown on the builders' hands; and, as high speed was to be one of the principal attractions in the yacht, the Baroness Rothschild agreed to pay a premium on each mile above thirty-six run in the two hours. As there is no way by which the yacht could be taken to Geneva complete, the Rhine being too rocky and rapid, and the yacht being too large for conveyance entire by rail, it was necessary to build her at Chiswick, take her to pieces, and send her, packed in boxes, to Geneva by rail. She was then erected at La Bellote, on the shores of the lake, by workmen sent from England. The trial was made on the 21st of September, the Baroness Rothschild and Lady Emily Peel being on board, and having as scientific advisers Messrs. Paul Carrié and Emile Sicard, French engineers. The distance between Geneva and Villeneuve, forty-three English miles, was run in 1 h. 48 min. 22 s., being at the rate of 23.89 English statute miles, or very nearly 20¾ knots per hour. During the first 20 miles a light head-wind and some waves were encoun-



ROAD LOCOMOTIVE FOR THE ENGLISH CHANNEL.

tered, which reduced the speed somewhat, but during the remainder of the run the lake was quite smooth; the boiler pressure averaged 100 pounds per square inch, vacuum twenty-four inches, and the engines made from 300 to 325 revolutions per minute, and developed about 450 indicated horse-power. At the conclusion of the trial the Baroness Rothschild expressed her entire satisfaction with the yacht and her performance.—*London Times.*

TRIALS OF THE 81-TON GUN.

A SERIES of experiments with this gun were lately conducted at the sea range at Shoeburyness.

After some trials at 3 degrees of elevation with the Palliser shell, the gun was elevated to 7 degrees, and the committee, with some officers, left the firing point in a wagon to go over the range to watch the firing near the spot where the projectiles might be expected first to hit the earth. The charge was still 370 lbs. of powder, and the projectile used was a Palliser chilled shell. The time of flight, taken at the firing point by Capt. Ellis, was 11.2 secs.—that is to say, before the first graze was made. The committee at the range found that the shot struck at 4683 yards from the firing point, and the blow on the sands made a trench 27 feet long, 12 feet wide, and 6 feet deep. They timed the flight as from the moment they saw the flash and the fall of the projectile, and they found, incidentally, that the conical ball travelled quicker than the sound of the report, for the blow came and the sound did not reach the party for a full second afterwards. The second shot was 11.4 secs. in making its first flight, and it fell at 4785 yards. The third made its first fall in 11.3 secs. at 4676 yards, and its second flight was seen at the range to be extraordinarily high. The fourth shot occupied 11.5 secs. in its time of flight, and struck earth at 4796 yards, while the fifth made its first flight in 11.3 secs., and struck earth at 4779 yards. The time of the second flight of this shot was seen and taken at 14.3 secs. It is believed that the full extent of the range of which the gun is capable, is about nine miles. Its great accuracy corresponds with its power.

Two shells, fired at an angle of 10 degrees of elevation, which, at a range of more than 6000 yards, fell so nearly on the same spot that they served to form one elliptical cavity in the sand, the points of impact being exactly abreast, and only about five yards apart. In respect to the performances of this immense piece of ordnance, it has been remarked that the noise of the report is not so loud as might be expected. Nevertheless, the enormous force which is at work is demonstrated by more than one species of evidence. The steady recoil of the gun carriage and its ponderous burden up the incline is itself a measure of the force with which the shot leaves the mouth of the piece.

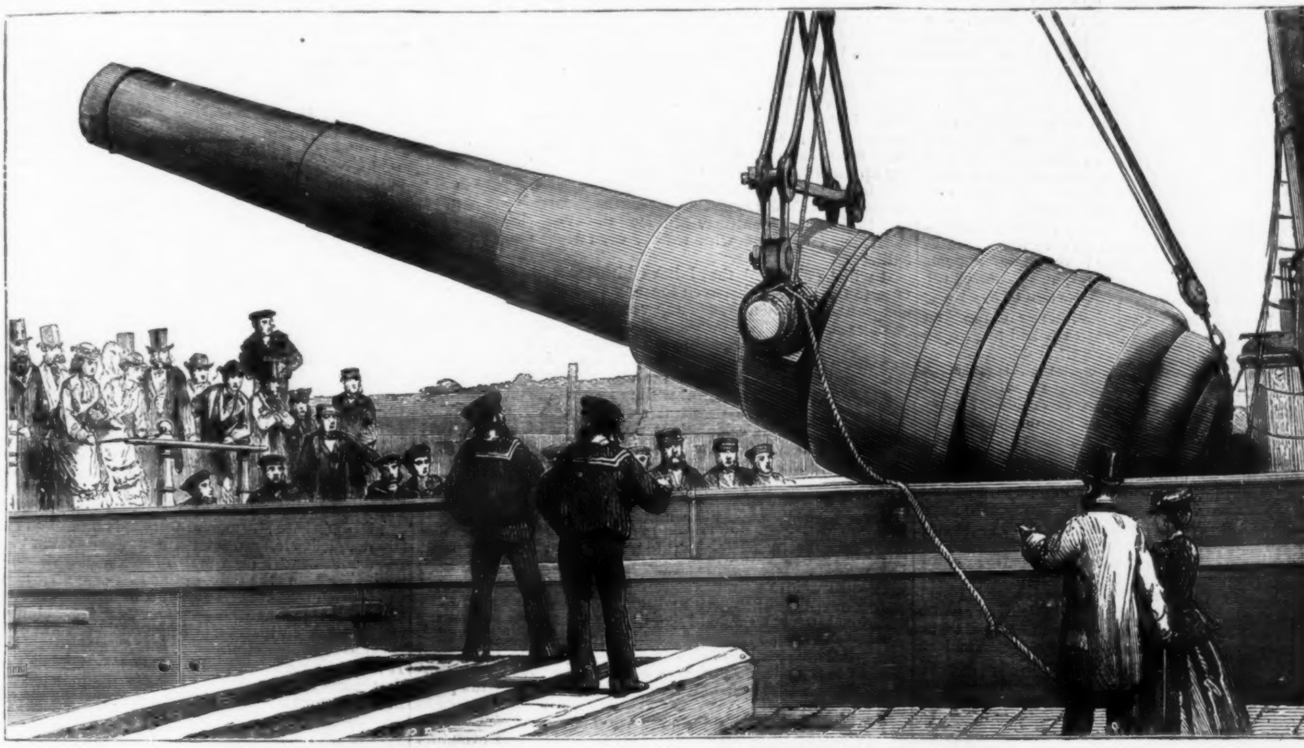
The gun, the carriage, and the bogies, with the loading truck attached, may be said to weigh about 126 tons, and the rate of recoil up the incline is about 9 feet per second, the total rise due to the ascendant gradient being about a foot and a quarter. The plan of the recoil platform is due to Major Maitland, the construction being carried out under the superintendence of Major Lambert, R.E. On reaching the end of its recoil the carriage is at once fixed at that point (which is some feet short of the end of the rails) by a party of artillerymen, who apply the brakes. When at the word of command the brakes are slackened, and the gun travels down the incline, the appearance of the monster, moving as if at "its own sweet will," is very striking.

Advancing another step we may speak of the steady and far-reaching flight of the great projectile, from 3½ to 4 feet in length, and weighing three quarters of a ton. From the firing place the course of the shot may be tracked a certain distance by the eye, while the sound of the shot falls upon the ear like the whirr of some huge wheel, the noise being singularly uniform, and somewhat subdued. After the shot has once struck either sand or water, the sound at once changes its character, a species of pulsation being observable, showing that the projectile has lost some of its steadiness. Of the amazing accuracy of flight prior to striking, complete evidence has been afforded by these trials. The 38-ton gun has done wonders in this respect; but the larger weapon has astonished every one by its precision of fire, especially as the carriage on which it has thus far been fired was not specially designed with reference to such a trial as this. When the "Inflexible" possesses her armament of four 81-ton guns, the mode of working these monster weapons will be altogether different from that which just now prevails at Shoeburyness, though it would seem as if the results already obtained could scarcely be improved upon.

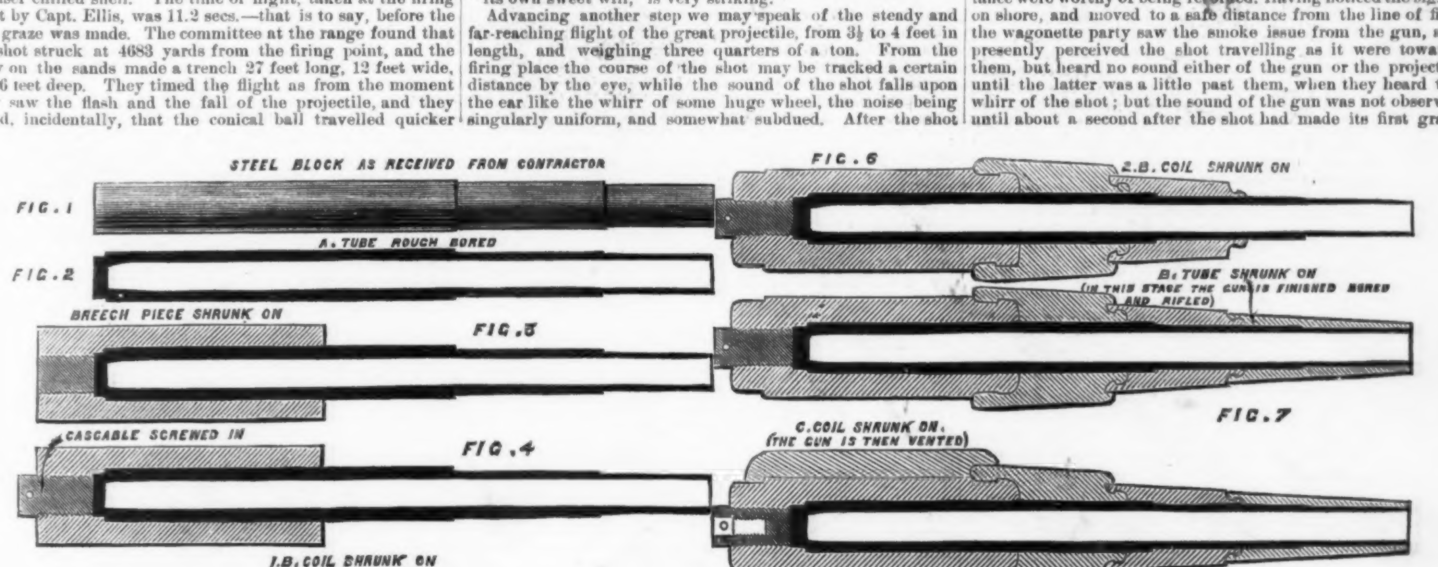
Associated with the ricochets are the uprising columns of sand and water. These are exceedingly picturesque, and are watched with much interest and admiration, though the magnitude of the columns is necessarily affected by the immense distance. When the firing takes place at a low angle, say 1 degree, the shot seems almost to skim along the surface—one huge jet after another flying upwards, until the last seems to spring from the very verge of the horizon. At the first blow, the mass which springs aloft is apt to be dark almost to blackness, and sometimes falls asunder in the midst, as if driven off by a lateral force. The subsequent jets are generally whiter, the water being unmixed with sand or mud.

The grooves cut in the sand by the shot are very striking when seen on the spot. Lately a party, including Colonel Younghusband, Major Maitland, Captain Owen, and others, proceeded across the sands in a wagonette to a distance of about two miles and a half, and found one of the holes made by the first graze of a shot which had been fired at an angle of 7 degrees. The outline was shaped like a pear, the narrow end being the entrance. The length was 27 ft., the breadth 12 ft., and the depth 6 ft. Some of the effects realized at this distance were worthy of being recorded. Having noticed the signal on shore, and moved to a safe distance from the line of fire, the wagonette party saw the smoke issue from the gun, and presently perceived the shot travelling as it were towards them, but heard no sound either of the gun or the projectile until the latter was a little past them, when they heard the whirr of the shot; but the sound of the gun was not observed until about a second after the shot had made its first graze on the sand, striking with a heavy thump, and throwing up the huge cloud already described.

The experiments were attended by General F. Campbell, the Director-General of Artillery, to whose foresight the nation is indebted for the possession of this gun, and the prospective possession of the four others now being constructed at Woolwich for the "Inflexible." There was also present Admiral Boys, and the experiments were witnessed by an officer from the Italian Government, France and Germany also having had scientific representatives present during some of the days. The gun was run up by Sergeant Tristram's detachment as soon as the tide was in, and the gun was loaded with the 370 lbs. of powder and a "live" shrapnel shell, with a bursting charge of 4 lbs. of powder, charged with 880 sand shot and 1083 4-ounce shot. The shell had a muzzle-loaded fuse—one which took its ignition from the flame of the



THE NEW 100-TON GUN.—MADE FOR ITALY.



HOW THE 81-TON GUN WAS MADE.

gun—and a gas check on the breach. When all was clear, Captain Ellis gave the signal to fire, and the gun, which was elevated to 5 degrees, exploded with what seemed a greater roar even than when charged with the uncharged shell. The projectile made a high trajectory, and burst well in the air at about 1200 yards' distance, the time of the burst being 2.7 secs. after leaving the muzzle. The charge spread very well, and could be seen dropping for some moments, and when the shell and its contents had disappeared beneath the waves the sound of the burst came to the firing point. The second shot, it was arranged, should be fired at a lower degree of elevation, this time at 3 degrees, with a like fuse to that in the first shot—namely, bored to 6-10ths, in order that the burst should be nearer to the water. The "scatter" of shot was an interesting sight, and was pronounced by the artillerists to be most successful.

In the concluding experiment the gun was loaded with 370 lbs. of powder, and a "case shot" was the projectile. The case shot is loaded with sand shot, and the whole weighs about the same as the other projectiles—1760 lbs. One degree of elevation was given to the gun, the Union Jack was run to the masthead as a warning to all whom it might concern to keep out of danger, and the bugle sounded for the benefit of those on land. The signal to fire was followed by a very great double explosion: that of the gun appearing sharper than on any of the other occasions, and the water was first struck within a hundred yards of the muzzle, the shot spreading in a manner which would have completely cut up and destroyed a column of troops if there had been one in front at the time. The ricochet of the shots carried some of the missiles in the case to about 1000 yards. There were 1874 8-ounce shots and about 300 small bullets in the case. The gas check was seen spinning along the water, and pieces of the case would have added to the general destruction of any thing in front. It was intended to examine the interior of the gun with a machine to see if any part of the case had broken up inside the gun, but as there was *prima-facie* evidence that this had not occurred, the committee contented themselves with an examination by Captain O'Callaghan, who took a view with a mirror of the rifling. It was decided, for the satisfaction of the naval authorities, to fire one more case shot, this time at a degree higher of elevation—namely, 2 degrees. The change of elevation was shown in the first graze being at a further distance, and the shot spread far and wide, as far as about 1800 yards, considerably damaging a flock of gulls, some of which were left dead upon the sands. The elevation throughout the day was taken with a tangent sight —the ordinary way of laying a gun, and not by the quadrant from the trunnion axis. This completed the experiments for the present, it being expected that the next will be, after some weeks, at the target now being erected by the Royal Engineers on the experimental grounds. With the results given, the members of the committee were understood to be highly satisfied. The skill of the Shoeburyness School of Gunnery, which holds the reputation of being the first of its kind in the world, was throughout shown to be equal to all the details of working this great instrument of warfare.—*Iron*

HOW THE 81-TON GUN WAS MADE.

THE following description of the manufacture of the 81-ton gun taken by *The Engineer* from a paper written by Major Maitland, R.A., the Assistant Superintendent of the Royal Gun Factories, for the last number of the "Royal Artillery Institution Proceedings," will be interesting to many of our readers:—

The preparation of this vast piece of ordnance—weighing more than twice as much as any previously made for service —may be divided into two parts; one being the actual making of the gun, the other the enlargement of lathes, the raising of roofs, the strengthening of cranes, bridges, and railways, with many other alterations which will readily suggest themselves. Besides these important points, there remain to be taken into account the projectiles and the carriage, while the powder question requires further consideration and experiment.

It will be best to begin with the gun itself. Those familiar with the heavy ordnance of our service will have noticed that of late years the thin coils and many-stepped outline belonging to the earlier models of the Armstrong system have gradually given place to the bolder curves and massive coils of what is known as the "Fraser" construction. The change has resulted in greater strength, endurance, and economy; and, as will be seen later on, these qualities, as far as yet tested, have been amply realized in the 81-ton gun.

The interior of the gun is formed by a solid-ended steel tube, procured from Messrs. Firth, of Sheffield. The manufacture of these tubes is, to a certain extent, a specialty. Without entering into the various controversies always going on regarding steel, it may certainly be affirmed that no other firm in England has succeeded, up to the present time in turning out the magnificent steel blocks required for our manufacture. That for the 81-ton gun weighed 16½ tons, and no flaws can be detected in it. The material used is entirely that known as crucible steel, being melted in about 240 small crucibles, whose contents are run into a large mould. The process is very expensive and eminently unscientific—having, indeed, nothing to recommend it but its success. This quality has, however, undoubtedly been attained by Messrs. Firth.

It is not requisite for me to describe minutely the details of the manufacture of our ordnance; I will merely indicate the successive processes of building up the 81-ton gun. Over the rear end of the steel tube is shrunk a very powerful coil, called the breech-piece. This is made of a single bar, 12 in. thick from inside to outside, hammered, rolled, and coiled—forming a cardinal point in the mode of construction. The cascable is next screwed in, so as to abut firmly against the solid end of the tube, and the B coils are then shrunk on into their places. The ponderous C coil, carrying the trunnions, comes last, and is in truth a marvellous piece of forging. It was made of two coils—one outside the other—and was 18 in. thick. These coils were welded together under the 40-ton hammer. It should be stated that, in order to obtain greater certainty of soundness and ease of manipulation, both the breech-piece and the C coil were made in two pieces, which were welded together, end to end; care being taken that the weld of the breech-piece was not inconveniently near that of the C coil.

The sketch appended gives a clear idea of the successive processes.

The now well-known principle of shrinking on the successive layers affords very great additional strength to the system, since by its aid the strain of the discharge is transmitted to the very exterior of the gun, which thus adds its quota to the resistance. The efficacy of the shrinking process is well shown by the measurements taken of the interior of the gun during manufacture. Thus the shrinkage of the powerful coiled breech-piece caused the bore to contract .020 in., and the compression of the massive outer coil carrying the trunnions was so great that it was transmitted through the breech-piece, and caused a further contraction of .023 in. in the bore.

The shrinkage was so adjusted that the maximum contraction (.043 in.) took place at a point 32 in. from the end of the bore, and gradually died away in each direction towards breech and muzzle. Thus the pressure of the gas—which is greatest in the powder-chamber and for a short distance in front of the base of the shot—was directly transmitted to the outer or C coil, the great strength and thickness of which form an important point in the system. It often happens, on firing a new gun, that the shock of discharge permits the atoms of the material to shake themselves, as it were, and to settle down more comfortably. This sometimes results in the shrinkage of the outer coils taking increased effect on the steel tube; but more usually the steel tube fits its exterior better to the interior of the coils, or perhaps slightly compresses their nearest particles, so that a small expansion ensues.

The gun, after firing twenty-one rounds, exhibited a slight contraction in front of 226 in. from the muzzle, and a slight expansion in rear of this point, both being so small that the bore may be said to be practically unaltered; and thus the outer coils retain undiminished their power of promptly taking up the strain imposed on the tube.

It may here be remarked that the object of the tube is not so much to afford transverse strength as to furnish a good and impenetrable surface. In fact, the Woolwich guns are constructed to stand with safety, even if the tube should split.

It will be observed that I have hitherto omitted all reference to the relation between the expected strain of the discharge and the thickness of the various layers of metal composing the gun. The fact is that no really trustworthy data exist for accurate calculations on this point. The time during which the maximum pressure is exerted is exceedingly small, and the rate at which the strain is taken up by the coils is altogether unknown; while experiments on masses of size sufficient to give practical results would be enormously expensive. Rough calculations do exist, but I confess that I do not put much faith in any of them; believing that, as a plain matter of fact, the real limit to the power that can be got out of a gun of the present construction, when suitable powders and shot are employed, lies in the recoil. I mean that we can increase the charge and weight of projectile of our guns, boring them up if required, till no carriages can be made to stand the shock, and that therefore a certain weight is necessary. It is obvious that, in any thing so risky as a gun, such weight as must be carried should be so disposed as to strengthen the piece to the utmost, even though some additional expense should be thereby incurred. Ordinary prudence demands this, and hence I do not consider the possession of a true theory of the relation between strain and dimensions to be at present of very great practical importance, though I fully admit its interest from a scientific point of view.

It was thought desirable, in order to obtain as much information as possible, to bore the 81-ton gun to 14½ in. in the first instance, and to increase the calibre by half an inch at a time till the full size of 16 in. should be reached. It is anticipated that, by carrying on experiments at each stage, much valuable knowledge relating to the behavior of powder and the manufacture of heavy projectiles will be acquired.

The gun was ready, in its 14½-in. calibre, for firing early in September, 1875, having taken just eighteen months to complete. Of this time, several months were occupied by the necessity for enlarging various parts of the plant in the Royal Gun Factories. The unprecedented size of the bars forming the coils entailed much heavy forge work, and the rolling mill then in use was not powerful enough to turn out such sections of iron; the coiling furnace required alteration; the roof of the tempering house, where the steel tube is toughened in oil, had to be raised; the hydraulic crane had to be patched up to take weights beyond its safe strength; a lathe and boring machine of immense length were obvious necessities; the railways, wherever the gun was intended to travel, required strengthening; the bridge over the canal was almost reconstructed; while the additions to the proof butt "made Ossa like a wart."

In our next paper we will give tables of the results obtained from the gun, which are interesting and instructive.

COMPASS CORRECTION IN IRON SHIPS.*

By Sir WILLIAM THOMSON.

THE distinguished author said this problem was set to Professor Airy, the Astronomer Royal, nearly forty years ago. Sir George Airy at that time made a very elaborate investigation of compass errors in ships, and proposed a method of correction which had been more or less in use ever since. His method was by steel magnets for part of the errors due, either to the permanent magnetism of the ship, or the magnetism induced by the vertical component of the magnetizing force. Another part of the error to be corrected was what is called the quadrantal error; that was produced by changing the magnetism which the ship experienced as she turned round into different positions, and was influenced in those different positions by the magnetizing force of the earth. The correction of the quadrantal error was masses of soft iron, not magnets, placed on the two sides of the compass. When these were properly applied the ship's compass would be correct as long as the ship remained in the same position. But if the ship heeled over, another error would arise; and Professor Airy showed how that was to be correccted; and the Astronomer Royal's plan was largely employed in merchant ships; but the results were not all that might be expected. Mr. Smith and Captain Evans investigated very carefully the effect of the quadrantal correctors, as they were called, and they found that they introduced other errors of a more dangerous kind than that which they correct, with the compasses actually used in merchant ships, especially large compasses, and compasses with only two needles or one needle. They also found that with the Admiralty compass this particularly dangerous error of the quadrantal correctors was escaped from, and the result was that the quadrantal correctors might be safely applied. Another point, however, was not looked upon by Smith and Evans, and that was the magnetism induced in the correctors by the influence of the compass needle. About half of the whole effect of the soft iron correctors was due to the indications of the magnetic needle in the correctors; and only one half was of the kind aimed at by the Astronomer Royal. What then was the evil they had to apprehend? As long as the ship remained in the same latitude, the quadrantal corrector with Smith's arrangement would answer; but in high northern latitudes the correction would be greatly overdone, and in southern latitudes the correction would be underdone. Now the great merit of the quadrantal corrector was this, that when once made for the ship it was perfect for ever. Having explained that the management of the compass on an iron ship was an enormous facility for the application of quadrantal error, he said the one thing needful for quadrantal correctness, supposed by the Astronomer Royal, and perfect for all latitudes, was a magnet on the compass guard whose magnet movement should be so small that their magnetizing influence on the correctors should exercise no sensible effect on themselves. When he took up this subject it came to him in this light that he must have much smaller needles than in the Admiralty compass. They would see how he had attained that result—by lightening as much as possible every thing except the arm which was to bear the card which they read off from. We could get the proper smallness of fractional error with exceedingly small needles. The largest was about 2¼ in. long, and his hearers could see how small they were. It was quite certain that the reflex action of these needles upon the quadrantal correctors would be quite insensible. As to the rapidity of vibration of the compass, to get a steady compass at sea it was quite necessary to have a long period of vibration. We had a compass which was very much steadier at sea than the Admiralty compass. Having given a caution against a free magnet in any part of the ship, as being exceedingly dangerous—as dangerous as dynamite—he showed a binnacle which had a means of applying a corrector for the first error. He had made an exceedingly simple method of adjustment which could be worked without screws, which would be always seen, and which, if wrong, would be seen to be wrong. The correctors of the quadrantal error were to be applied by larger or smaller sizes of soft iron. When you had got the quadrantal error corrected, it was an easy matter to get the compasses corrected without sights of sun or stars. He showed that his plan did not prevent azimuth observations; and he said there were some minor advantages of hardness, and ability to stand rough usage.

OILS AND FAT DESTRUCTIVE TO IRON.

AT a meeting of the Industrial Association of Moravia, held at Brunn, M. G. Ruckensteiner commented on the destructive influence of pure animal and vegetable fats upon steam engines and boilers. These bodies are decomposed by the action of high-pressure steam, and fatty acids (such as the margaric, stearic, oleic, etc.) are set at liberty, and attack the iron, as he has demonstrated in a series of experiments. He therefore recommends, as the only means of preserving machinery, the use of such mineral oils as boil at high temperatures, whereby wear and tear of machinery and the consumption of grease are reduced. Mineral oils do not contain fatty acids, are incapable of being decomposed, and do not form insoluble soaps. If they become mixed with boiler incrustation they diminish its tendency to cling to the sides of the boiler, and thus exert in this respect also a beneficial action.

MANUFACTURE OF ARTIFICIAL BUTTER.*

By HENRY A. MOTT, JR., E.M., Ph.D.

[With Six Illustrations.]

FOR a number of years past attempts have been made to manufacture butter from substances other than cream. I propose in this article to consider only those processes that have been suggested, from time to time, for the manufacture of butter from caul fat (suet); as the product that can be now manufactured by my process from caul fat is as good, if not equal, to the best butter made from cream. With respect to its preservative power, it is undoubtedly much better.

A brief history of the different patents obtained for manufacturing a substitute for butter will, I think, not be out of place.

HISTORY.

I know of no patent previous to the one issued by Mége in England, July 17th, 1869, that has any connection with that subject. I am acquainted with the fact that William Palmer took out a patent in England in 1846 for "Treating fat or fatty matters from beef, mutton, veal and lamb;" but the product obtained by following the specifications set forth in his patent in no way resembled butter. It was a product similar to lard, (and as the specifications state) "but will not have the odor, flavor or taste of lard;" this is owing to the fact that the product is flavored with "bay leaves." Mége's patent was not issued in this country until December 30th, 1873, after several processes had been in active operation for the manufacture of artificial butter. I will very briefly consider the different processes, as they were completely swept out of existence after the introduction of Mége's patent.

The first process was patented by H. W. Bradley, January 3d, 1871. His specifications claim that the investigation relates to a new composition for lard, butter or shortening, whereby a very cheap, consistent and coagulate lard or butter is manufactured, and one superior to ordinary shortening, answering the purpose of lard, butter or cream, for culinary and other uses or purposes. The product manufactured is composed of beef or mutton suet (tallow), refined vegetable or fixed oils, hog's lard or stearine. Bradley's next patent, issued October 7th, 1871, had for its object "to deodorize and render palatable cotton-seed oil for culinary use." It is very evident, from the facts stated, that no further consideration of the Bradley patents are necessary.

The next process proposed was patented by Peyrouse, November 2d, 1871. The specifications had for one object, "To enable the application of fine fats, especially beef fat, to alimentary and culinary purposes, and make such fat take a position between butter and lard, give it a good appearance, smell and taste, and give it digestible qualities far superior to the freshest butter or lard." The product in this case is a mixture of beef fat, bicarbonate of soda, chloride of alumina, and chloride of sodium, and, of course, in no way resembles butter. The next process I will consider was patented by Paraf, April, 1873. The specifications in this patent approach what I call "the true process for the manufacture of artificial butter," and for a very good reason, namely, that Paraf read in a French journal an account of Mége's process for manufacturing artificial butter, and stated in the presence of a friend of mine that he would patent the same in this country to-morrow, which he carried into effect at short notice. The product manufactured under the specifications set forth in Paraf's patent was called "oleo-margarine" butter, at one time was considered a compound principally com-

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posed of olein and margarine, but later investigations have shown that margarine is a mixture of palmitin and stearin. Paraf started a large company, called the "Oleo-margarine Manufacturing Company," in this city, having for its object the manufacture of the "oleo-margarine" so called. It is unnecessary to review the process adopted by Paraf, as it is similar to Mége's process, which will have to be considered at length. Suffice it to say that the product manufactured by Paraf's process, when just made, resembles butter at a distance, but on examination with the microscope it is seen to possess a distinct grain, which is very distinguishable on tasting; it possesses no odor or flavor of butter, and after keeping a short time loses its color (which is always more or less red), and acquires an odor of beef suet, from which it is manufactured. Before the issue of Mége's American patent there was a patent obtained by Joseph Brown, December 23d, 1873, for purifying tallow, removing its smell, and rendering it hard at all seasons of the year. The product manufactured will of course still remain tallow, and, therefore, can not be called butter.

The next process to be considered is Mége's process, patented in England on July 17th, 1869, and finally patented in this country December 30th, 1873, and reissued May 12th, 1874. The reissue contains all the valuable points in both Mége's English and first American patent; this reissue as well as first patent is the property of the United States Dairy Company. Mége patents the two principal operations in the manufacturing of butter from animal fats: first, the extraction of the oil at a low temperature from the fat; second, the converting of the oil by churning with milk into butter.

Whilst Mége has patented the two important operations mentioned above, it must not be forgotten that each operation must be carried on or elaborated according to certain formulæ to produce a product such as is now produced and such as will find a ready sale. These formulæ, however, Mége failed to discover, for when caul fat is treated by any one or all of the processes proposed by him, the product is little more than refined fat in some cases, and in others not so good. It is not salable in the market at hardly any price. I speak from actual experience, having made under my own directions, by order of the United States Dairy Company, samples of butter by each of the processes set forth in the patent. I am referring of course, only to the butter, for the oil produced at a low temperature, as proposed by Mége, has a very extensive sale and demand in the market for manufacturing into cheese, soaps, and by my process into butter. It will be necessary to state here, very briefly, the different operations as set forth in Mége's patent. Caul fat free from blood, after thorough washing in water, is disintegrated in an ordinary meat hasher, is melted at the very lowest possible temperature—never above 125° F.—in a tank surrounded by water. The melted fat, after separating from the membrane or scrap, is received in a suitable vessel, and allowed to solidify, when it is packed in cotton bags and subjected to pressure at a temperature of about 89° F. The oil pressed out is collected and treated further according to the requirements of the product.

For butter that is to be immediately used, the product obtained possessed a grain, an odor and decided flavor of soda, without having any resemblance to butter other than its color.

For "butter to be preserved" the product obtained was even poorer than that above mentioned, not possessing the appearance of butter, and still having the odor and flavor of soda.

For "butter needed for long preservation" the product obtained was simply refined fat, having the odor and flavor of suet.

In conducting my experiments my object was to manufacture a product containing no element foreign to the very best of butter.

My first discovery was a process by which I was enabled completely to remove the grain from the artificial product.

About 100 lbs. of oil (from the press) were put in a churn with 33½ lbs. of milk and 2½ to 3 ozs. of solution of annatto, mixed with ½ to ¾ oz. of bicarbonate of soda. The mixture was thoroughly agitated, and then drawn off in a tub containing pounded ice, which was kept in constant motion until the tub was filled. The solidified oil was then allowed to stand for two or more hours, when it was dumped on an inclined table to allow the melted ice (water) to drain off. The product was next worked with salt, and packed in firkins for sale. The material thus produced possessed no grain, and had the true color of butter, the red of the annatto being completely neutralized or removed by the addition of the small quantity of bicarbonate of soda—quite a different quantity as proposed by Mége. I only arrived at the correct amount after a number of experiments. Although this product found a market for butter to be immediately used, still I discovered in a short time that it lost all odor and flavor of butter owing to the complete removal of the milk, and the same by the action of the ice. How to introduce into the product the true butter odor and flavor without injuring the texture, was a problem of considerable difficulty; but after working over three months on the product I discovered the true process, which is described farther on.

A number of other patents are yet to be considered, the object of which is to manufacture either the oil or the butter without infringing on Mége's patent. This is an impossibility, as Mége has patented the "extraction of the oil at a low temperature," and a low temperature is actually required to produce a sweet oil capable of being used to manufacture butter, as proven by a number of experiments of Dr. Chandler, as also many by myself. Francis Kraft obtained a patent for separating stearine from olein July 21st, 1874. He accomplished his object by melting at a low temperature with a mixture of chemicals. Wm. E. Andrew took out a patent August 11th, 1874, for separating oleo-margarine and stearine from animal fats. The process he adopts is applying dry hot air to the fat enclosed in bags in a press, thus separating the oil from the stearine. Still he accomplishes his object at a low temperature. John Hobbs took out a patent August 18th, 1874, for "Improvement in Treating Animal Fats." The product produced by following the specifications as set forth in this patent is a mixture of tallow and butter, and of course very inferior to butter made from cream.

Wm. L. Churchill and Jacob L. Englehart took out a patent August 25th, 1874, for "Improvement in Treating Animal Fats, and Manufacturing Artificial Butter." According to the specifications, the fat is melted truly in a peculiar vessel, but still at a low temperature; the fat is then pressed. The oil produced is then churned with buttermilk, and a product obtained which is called butter, but of course possesses a grain and all the other properties peculiar to the oleo-margarine of Paraf. George Bloom Van Brunt took out a patent October 13th, 1874, for "Improvement in Processes of Manufacturing Products from Animal Fats." The product manufactured in this case he calls oleo-palmitin, which of course is not butter.

The next patent to be considered is one granted to Wm. E. Andrew, August 24th, 1875. The process set forth in his patent for removing the grain, and introducing the flavor of butter, etc., is the process discovered by myself. I will not say that Mr. Andrew was informed of my discovery, although it looks very like it, as I had successfully used the process a year before he had obtained his patent, which was not obtained until August 24th, 1875. With respect to the grain, I had completely removed the same some three years before that, which facts I am ready to prove at any time. John P. Kinney took out a patent October 19th, 1875, for "Improvement in Processes in Purifying and Preserving Animal Fats." The product, produced as is claimed, is simply purified fat, not butter.

The next patent in order is one granted to Wm. E. Andrew, which is a reissue (Nov. 16th, 1875) of his patent August 11th, 1874. The object of the process is to produce an oil (which he calls elaine), suitable for transforming into butter. This is accomplished at a low temperature. He says in the specifications the temperature should be about 140° F.; the higher the temperature, the more rapid the yield. This last statement is certainly correct, but he should have added, the poorer the oil. The temperature even of 140° F. is a great deal too high to produce a sweet oil, as numerous experiments have shown.

Garret Cosine took out a patent February 15, 1876, for "Improvement in Processes for Making Artificial Butter." The object of the process is to make two products called butter—one for winter use, and the other for summer. The winter product consists of olein and fruit or nut oil flavored with milk, and salted. The summer product is similar to the product manufactured by Paraf, not salable in the market.

The oil is extracted from the fat at a low temperature, but, as is claimed, by the process described by Chevreul in Brande's work on Chemistry. I have referred to Brande's Chemistry, vol. ii., page 1264 (sixth ed., 1848), and find the following: "It has already been stated that animal fat is contained in what is termed adipose membrane, or cellular tissue; that it may be obtained by exposure to heat sufficient to liquefy the fat, and burst its including cells; and this should be done before any putrefaction of the membrane or of the blood, fibre, and other accidental adhering matters has taken place. To facilitate the operation, the fat should be chopped up into small pieces, so as to allow of the more uniform influence of heat." Brande further says, speaking of beef fat: "It fuses at about 100° F."

With respect to the above quotation, it will be noticed that no mention is made of the oil or refined fat produced being perfectly inodorless and sweet, nor is the temperature stated at which the chopped fat is melted. These are two very important points, for it is impossible to melt the fat, when only chopped up (instead of being reduced to a pulp by grinding, or by passing the same through a hasher), at a temperature of 125° F.; and experiments, as I have stated, made by Dr. Chandler, as also by myself, have demonstrated that for the oil to be sweet and inodorless the fat must be melted at the lowest possible temperature, never above 123° or 125° F. This can only be accomplished by the reduction of the fat enclosed in its membrane to a pulp. Therefore an oil produced even at 125° Fah., or above, will be tainted by the decomposition of the animal membrane. There is sufficient proof in the fact that perfumers have always had to adopt some elaborate process for rendering the oil inodorless and sweet, that had been made by processes before Mége discovered the true one.

With respect to the temperature given by Brande for the fusing point of beef fat, 100° F., it is only necessary to say that he refers only to the fat freed from its membrane, as the fat can not be separated from its membrane under 109° F. (Walsh), and that only in very exceptional cases.

I have carefully reviewed the literature on the subject of oils and fats as far back as 1800, and can find nowhere mentioned a process for the extraction of a sweet, inodorless oil from beef fat or other fats, before the mention of Mége's discovery, which has been patented by him, and over which no other patent has a priority, as shown above.

THE TRUE PROCESS FOR MAKING ARTIFICIAL BUTTER.

The first matter to be attended to when a good product is to be manufactured is cleanliness. I start off with this most important point, to which the strictest attention must be paid.

WASHING PROCESS.

The fat, on arriving at the factory, is first weighed, and then thrown piece by piece into large tanks containing tepid water, care being taken to place all pieces covered with blood into a separate tank to be washed. The fat in the tanks should now be covered entirely with tepid water, and left at rest for about one hour, when the tepid water should be removed and the fat thoroughly washed with cold water, then covered with fresh cold water, and allowed to rest for one hour longer; the water is then again removed, and the fat thoroughly washed, for the last time, with fresh cold water, when it is ready for the next operation. The

DISINTEGRATING PROCESS

consists in disintegrating the fat by passing it through a "meat hasher." To do this, the fat in the tank is removed by means of a wooden car to the side of the hasher, where it is cut with a knife into pieces about five or six inches square. Piece by piece it is introduced into the hasher, which, by means of the revolving knife within, cuts the fat very fine and forces it through a fine sieve at the opposite end, and finally out of the machine and into a tub. Care must be taken not to introduce the fat in the hasher too rapidly, as the sieve or knife is apt to snap, for it requires considerable power for the disintegration, which is, of course, accomplished by steam.

MELTING PROCESS.

The fat, now in a disintegrated state, is removed to the melting tank, care being taken not to introduce into the tank any of the water which is forced out of the fat during the disintegrating process. The fat is then heated by means of the water surrounding the tank, until the temperature reaches 116° F., when the steam which heats the water is turned off. The water surrounding the tank being much warmer than the molten fat, increases the temperature of the fat to about 122° to 124° F., when the fat completely melts. During the whole operation from the time the steam is turned on until the melted fat is allowed to rest, the fat must be continually stirred, so that an even temperature may be maintained. The adipose membrane of the scrap, called "scrap," separates and settles to the bottom, on leaving the melted fat at rest, and a clear yellow oil floats on top, covered by a film of white emulsion of oil with the water contained in the fat.

When the scrap has completely settled, the thin layer of emulsion is bailed off, and the clean yellow oil is drawn and received in wooden cars, which, when filled to within one inch of the top, are removed to some place, to allow the oil to solidify. Care must be taken in drawing off the last portion of the oil not to allow any of the scrap to mix again with it. It is better to receive the last portion of the oil and scrap in a small galvanized iron can, and allow it to cool by itself, and when cool to melt it over again by placing the can in one of the wash-tubs and surrounding it with water heated to about 125° F., and thus separate from the scrap all the oil that is possible.

It sometimes occurs that the scrap refuses to settle, and rises to the surface, forming a layer on top of the clear oil. If such be the case, the melted fat and scrap must be stirred up together for at least ten or fifteen minutes, and then allowed to settle by standing, which it will generally do. If it does not, then it should be again stirred, and allowed to stand; and if another failure follows, a quart or two of salt must be thrown on the scrap and the mixture stirred, when the scrap will soon settle to the bottom after standing.

An acid solution of the active principle of the stomach of a calf was used for some time, as proposed by Mége, in the melting process. It was thought to coagulate the "scrap" and cause it to settle more rapidly. Experiments have shown it to be unnecessary, however. The melting process, when conducted with success, occupies about 2 or 3 hours. The oil in the cars will require at least 12 or 24 hours or more to granulate, and the temperature of the room should be about 70° F. This is a very important operation, and must not be hurried, otherwise the stearine in the fat will not have time to crystallize.

PRESS PROCESS.

The car containing the solidified oil from the melting process (which for convenience hereafter I will call refined fat) is removed to the press room, which room is kept at a temperature between 85° F. and 90° F.

The refined fat must not be so solid that it can not be worked with the fingers with ease; if it is, it must be left in the press room until it softens. When in the right condition it is packed in cloths, set in moulds to form packages about 4 in. wide, 8 in. long, and 1½ in. thick. These packages are then placed on galvanized iron plates in the press, at equal distances apart. The plates are piled one above the other until the capacity of the press is thus utilized, when the packages are subjected to a slight pressure, which must be increased very gradually, and only after the oil pressed out begins to flow very slowly. The oil is received in a tin vessel, which, when filled, is replaced by another. The pressing is continued until no more oil can be obtained at the temperature of the room. The pressure is then removed and the plates unpacked, when cakes of pure white stearine are obtained, having the dimensions of about 8 in. × 5 in. × ½ in. The stearine after the removal of the cloths is ready for sale. The cloths are put in one of the tanks containing hot water, until all the oil and stearine is melted off, when they are washed in another tank, and then hung up to dry. The oil and stearine in the first tank are solidified by means of cold water, collected and sold as soap grease.

The oil obtained from the press is removed to some cool place, until it assumes a temperature of about 70° F., when it is ready for the next operation.

CHURNING PROCESS.

The treatment of the oil from now on is conducted exclusively by my process, and success in the business depends on the result of this operation, which is always successful in producing a good product (provided the oil has been properly made), when the following is closely adhered to:

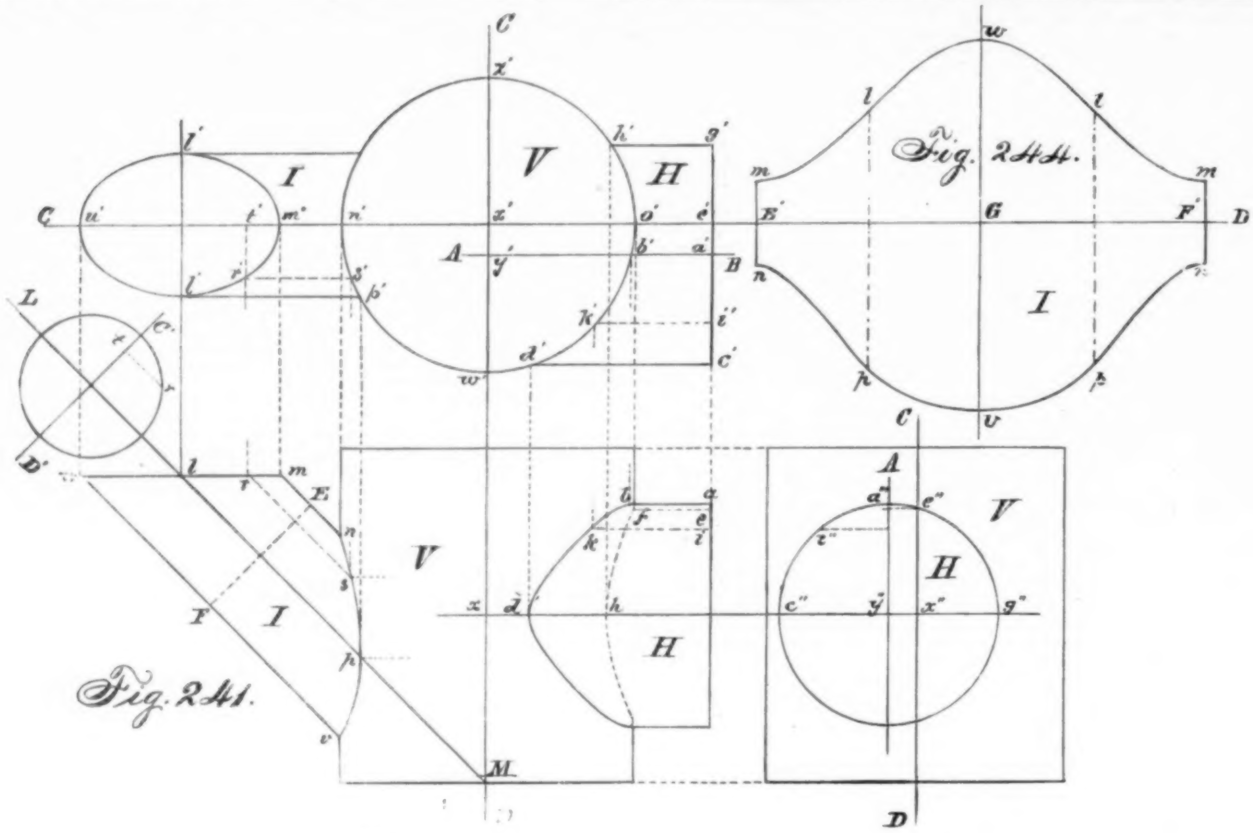
The oil now at the proper temperature (70° F.) is removed to the churning room. One hundred pounds of oil are introduced into the churn at a time, with from 15 to 20 lbs. of sour milk. About 3 or 2½ ounces of solution of annatto, to which has been added from ½ to ¾ of an ounce of bicarbonate of soda, may now be added, and the whole agitated for about ten or fifteen minutes, until milk, coloring matter and oil are thoroughly mixed together, when the whole mixture is withdrawn from the churn, through a hole at one end, and allowed to fall in a tub containing pounded ice. As the oil flows on the ice it must be kept in constant motion until the tub is filled with solidified oil, when another tub is put in its place. The grain is by this simple process completely removed. The solidified oil, which has a slight orange* color, is left about two or three hours in contact with the ice in the tubs, when it is dumped on an inclined table, where it is crumbled up so that the ice may melt and leave the solidified oil, which is then crumbled up fine by hand, and about 30 lbs. of it at a time are introduced into a churn, with about 20 to 25 lbs. of churned sour milk, and the whole agitated for about 15 minutes, when the solidified oil takes up a certain percentage of the milk, as also the flavor and odor (which were by the ice washed out from the first churning), and pure butter is produced. This is now removed from the churn to the working table, where, after standing and draining for a time, it is salted, to the extent of ¾ to 1 ounce of salt to the pound of butter.

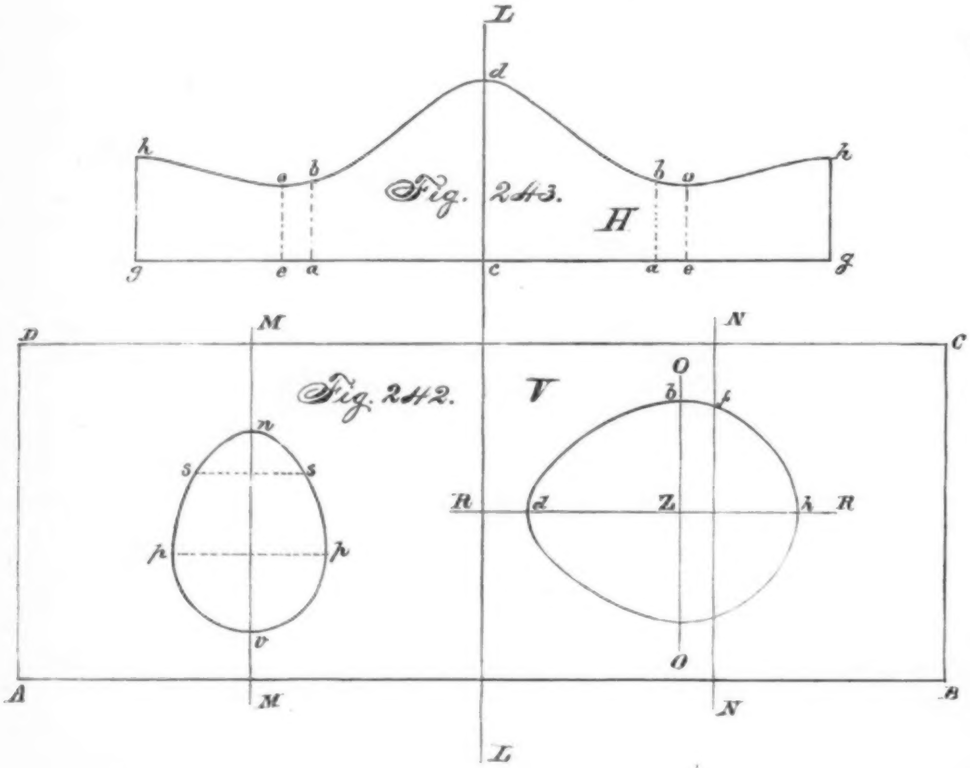
After proper working and standing for a sufficient length of time it is packed into firkins and is ready for sale. The butter thus produced contains nothing foreign to the very best of butter, and this has been the object to which I have devoted so much attention. When prepared as above, it has always found a ready sale in the market, as its keeping qualities are far superior to butter made by churning milk or cream. The percentage of butyrine, caprin, caproin, etc., it contains is very small (being derived from the milk in the last churning process), not sufficient to make the butter become rancid, but quite sufficient to give to the butter the so-much-prized flavor and odor.

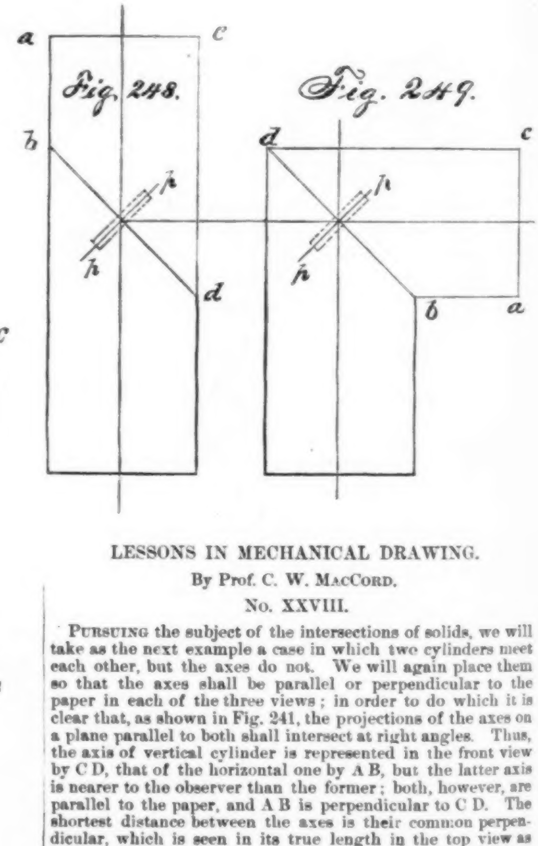
I sent a sample of butter made by the above process to the Hon. X. A. Willard, the President of the New York State Dairymen's Association, who is considered one of the highest authorities in this country on any thing connected with dairy products. He says, in a letter to me on the subject: "The sample of butter sent is far superior to any I have seen, in flavor and texture. I have shown it to a number of experts in butter, and they are greatly surprised at its flavor. If you could produce a more waxy texture in the article, it would puzzle *some* to detect it from genuine butter." This from a man of acknowledged ability is sufficient to endorse all that I have said with respect to the product. With respect to the waxy texture—this property the artificial product acquires on standing a short time.

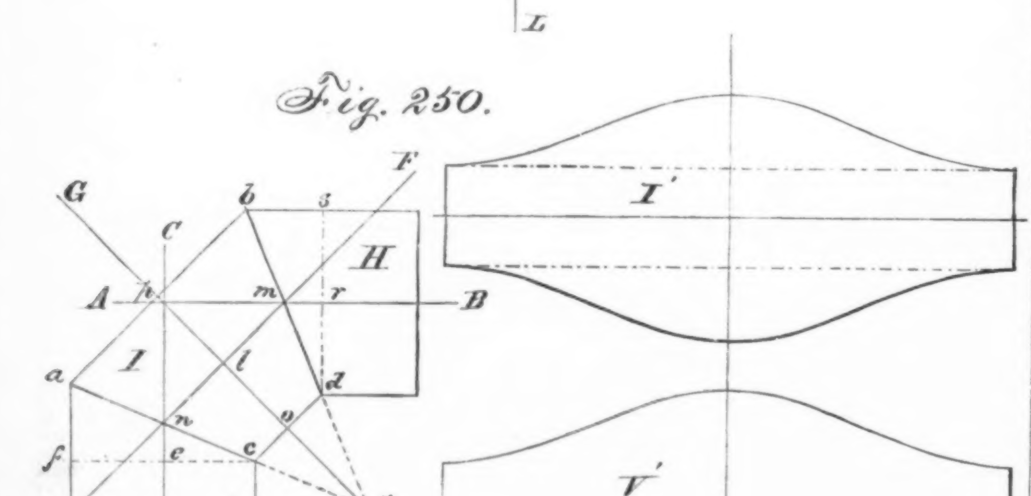
(To be concluded.)

* The color is made purposely a slight orange color so that in the last churning process just sufficient color is destroyed to leave the product with the proper color.









LESSONS IN MECHANICAL DRAWING.—No. 28.

LESSONS IN MECHANICAL DRAWING.

By Prof. C. W. MacCord.

No. XXVIII.

Pursuing the subject of the intersections of solids, we will take as the next example a case in which two cylinders meet each other, but the axes do not. We will again place them so that the axes shall be parallel or perpendicular to the paper in each of the three views; in order to do which it is clear that, as shown in Fig. 241, the projections of the axes on a plane parallel to both shall intersect at right angles. Thus, the axis of vertical cylinder is represented in the front view by C D, that of the horizontal one by A B, but the latter axis is nearer to the observer than the former; both, however, are parallel to the paper, and A B is perpendicular to C D. The shortest distance between the axes is their common perpendicular, which is seen in its true length in the top view as $x' y'$, in the side view as $x'' y''$; and it appears in the front view as X, the intersection of A B and C D, the projections of the axes. With this explanation we think the reader will be able to form a clear idea of the relative positions of the two solids. In regard to the lettering it should be further stated, that according to custom the location of the centre of the vertical cylinder in the top view is fixed by drawing two centre lines, which are for simplicity both marked C D; so also in the side view the vertical and the horizontal centre lines of the other cylinder are marked with the same letters, A, B.

Now, to find the curve of intersection. It will be seen at once that the horizontal line $c\,d$, on the nearest side of the smaller cylinder, will appear in the top view as $c'\,d'$, and thus determine d', whence we find d, exactly as in the preceding example. And the mode of finding other points is substantially the same, but the results are a little different: thus the highest element of the horizontal cylinder, $a\,b$, does not meet the right-hand element of the vertical one, being nearer to us; but we can find just as easily as before the point in which it does pierce the larger cylinder, which in the top view must be b', where the circle cuts $a'\,b'$. The right-hand element of the vertical cylinder, through o, will appear in the side view as coincident with the centre line C D, and pierce the horizontal cylinder at a point seen in that view as e'', which in the front view will be found on the horizontal element $e\,f$ at the same level with e''; therefore f, the intersection of $e\,f$ with the right-hand vertical element spoken of, will be the point sought.

Behind $c\,d$, there is another horizontal line seen in the top view as $g'\,h'$, in the side view as the point g''; h' is therefore the top view, and h, perpendicularly under it on $c\,d$, the front view, of the point in which this horizontal element of the smaller cylinder pierces the larger one.

By proceeding as in the example given in **Fig. 235**, we may find any number thought necessary of the other points in the curve; thus drawing $i'\,k'$ in the top view, it corresponds to a point i'' in the side view, the distance to the left of A B being equal to $a'\,i'$; then $i\,k$ is drawn on the same level with i'', and k found by letting fall a vertical line from k'. The curve thus constructed will evidently be divided symmetrically by the horizontal line A B, and will have, like the one in Fig. 235, a vertical tangent at d. From that point or vertex it rises and goes to the right through k, and is tangent to $a\,b$ at the highest point b; there turning, it begins to descend, still, however, going to the right until it reaches f, where it is tangent to $o\,f$, the right-hand outline of the vertical cylinder, and then again turns to the left, and continues to move in that direction until it reaches h, at which point it has another vertical tangent.

In the same figure we have introduced another case, in which the axes of the two cylinders intersect at an acute angle. The centre line of the inclined cylinder is L M on the left, in the front view, and in the top view it will be of course C D. The upper end of this cylinder is not at right angles to the axis, but is terminated by a horizontal plane. Consequently in the top view of the whole, the end of the inclined cylinder will appear as an ellipse, of which the minor axis is $l'\,l'$, equal to the diameter, and the major axis is $u'\,m'$. But in order distinctly to indicate at a glance the form of this inclined solid, we make a direct end view, which is connected breadth of this opening will be at $p\,p$, whose distance from the base is the same as that of p in the front view, and the breadth itself is of course equal to twice the rectified arc $n'\,p'$ in the top view.

Also bisect L C, and at the point of bisection draw another vertical centre line N N. Now, this last is not a centre line in relation to the opening for the cylinder H, in the sense of dividing that opening symmetrically as in the other case; it is in fact only a *centre* line, strictly speaking, of the developed surface of the right-hand half of the cylinder V. But it is an important line for that very reason; when the sheet is cut out and rolled up, the opening must be in the proper place, which is on the right-hand side of the cylinder, just as that of the other one is on the left-hand side; and these two lines, M M and N N, have, one may say, a natural claim to be considered as landmarks to which other localities are referred. At a distance to the left of N N, equal to the length of the arc $o'\,b'$, draw another vertical line O O; on this will be found the highest point b, and also the lowest. This curve is symmetrically divided by the horizontal centre line R R, on the same level with A B; and on R R will be found the extreme points, d on the left, h on the right. Their positions are determined by rectifying separately the arcs $b'\,d'$, $b'\,h'$, and setting them off from O O in the proper directions. The point f will be found on N N, at the same level with $e\,f$ in the side view; any number of other points may be found, precisely as in the previous cases: thus the distance of k above R R is the same as that of $i\,k$ above A B, and its distance from O O equal to the length of the arc $o'\,k$. And the student will see the advantage of pursuing the system previously suggested, that is, of dividing the arc $o'\,d'$ into equal parts, and its rectification Z d into the same number, in order to save the trouble of determining separately the lengths of several arbitrary arcs. The same system may be adopted with satisfactory results in determining the form of the other aperture, unless its length be considerably greater than its breadth; in which case it will be better to divide the length $m\,v$ into some number of equal parts, and determine the horizontal ordinates by rectifying the arcs corresponding to them: the labor involved is greater, but the gain in accuracy more than counterbalances it.

dividing the circumference into equal parts being very obvious in this instance.

The next example is the case of a cone penetrated by a cylinder, of which the axes are parallel. Since we are at liberty to place the solids in the most convenient position for our operations, we will suppose the axes to be vertical, and parallel to the paper in the front view, as in Fig. 245; C D being the axis of the cone, A B that of the cylinder. It will be seen at once that the extreme visible elements of the cylinder, on the right and left, both meet the right-hand element $v\,b$ of the cone, so that d and f, the highest and lowest points of the intersection, are immediately determined. Now through any point g of the axis draw a horizontal plane, or what is the same thing in effect, draw round the cone at that altitude a horizontal circle, of which the radius is $g\,h$, or in the top view $v'\,h'$. As seen in this top view, the circle will be intercepted by the cylinder at the two points i', i'', one of which is directly behind the other; the nearer one will therefore be seen at i in the front view. In the same way we may find any number of points, and no other need be used. But it is well to note that we may use another method if we choose. Thus, we may draw on the cone any right-line element, as $v\,k$, which appears as $v'\,k'$ in the top view, where it is seen to be cut by the cylinder in two points, m', n', which will be seen in the front view as m and n.

In this instance, however, we drew $v'\,k'$ first, and found the position of the element in the front view from it by projecting k' up to the base of the cone at k. This was done, and the line $v'\,k'$ drawn through m', for the purpose of determining the particular point m at which the nearest element of the cylinder would pierce the cone. Which might, however, have been done on the principle of the first mode, by describing the circle through m' to determine l', whence we might have found l by projecting l' up to the left-hand element $a\,v$, and the horizontal through l would also have given m. But in one special case the second method should be used, even if the first one be employed in finding all the other points. If we draw $v'\,o'$ tangent to the circumference of the cylinder in the top view, and from it find $v\,o$, this element will be tangent to the curve of intersection, which is thus more accurately limited than it can be in any other manner. Practically it will not matter much whether we know the exact point of tangency or not; but if we wish to locate it, it can easily be done, thus: First find the point p at which $v'\,o'$ is tangent to the base of the cylinder, by letting fall on the tangent the perpendicular from the centre of the circle. We may then either project p' vertically up to $v\,o$, and thus find p the required point, or we may use the other method, describing a circle through p' to cut $a'\,v'$ in r', project r' up to $a\,v$ in order to find r, and draw through r the horizontal to find p, precisely as described in reference to m.

The determination of this limiting tangent is particularly useful in developing the cone, for the reason that the element will remain tangent to the curve when developed, as shown in Fig. 246. For supposing the cone to be cut along the element $a\,v$, the opposite element $b\,v$ will appear as B V, and the element of tangency $v\,o$ as V O, the arc B O being equal to the arc $b'\,o'$; also V F, V D, will be equal to $v\,f$, $v\,d$, respectively; thus the curve is confined within definite limits, and even if the point of tangency were not known, the fact that the curve will not cut, but will touch, V O will be found an excellent guide in drawing it. We take this opportunity to repeat what we have several times said in substance if not in this exact form, that lines of any kind, straight or curved, circular or otherwise, which are known to be tangent to a line required to be drawn, are very valuable aids in the correct drawing of the latter; they not only limit its extension, but they control

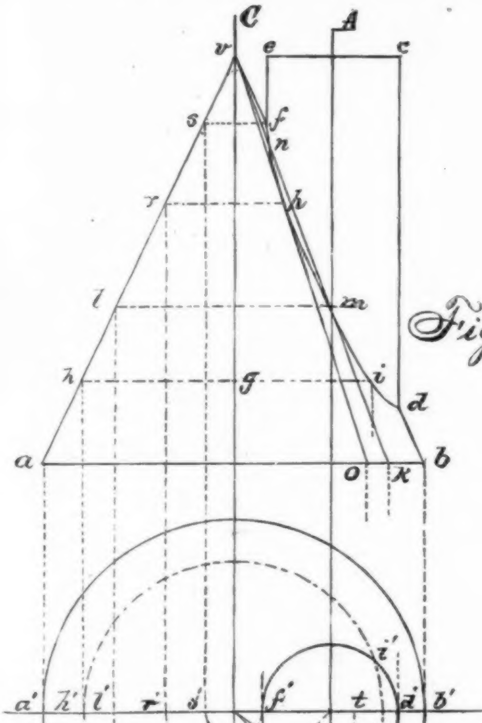


Fig. 245.

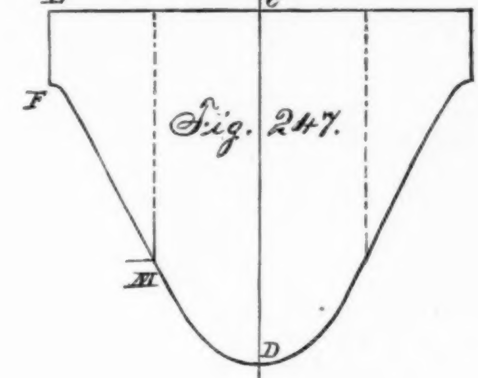


Fig. 247.

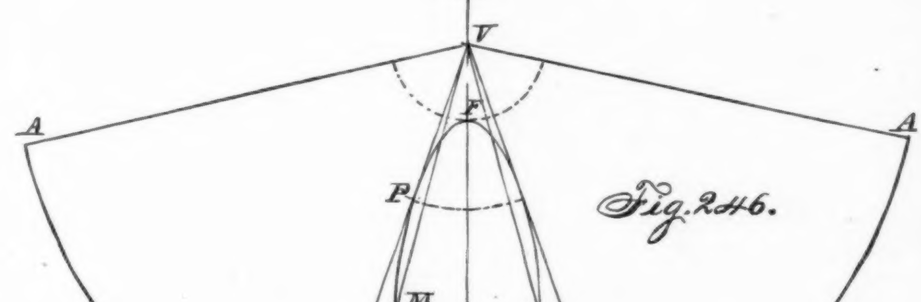


Fig. 246.

LESSONS IN MECHANICAL DRAWING.—No. 28.

with the side view by prolonging L M; the other centre line, C′ D′, is perpendicular to L M, and the circle thus represents the cylinder as seen directly from the end. The highest element, $m\,n$, intersects the left-hand element of the vertical solid at n, and the lowest, $u\,v$, cuts it at v. Other points are found in almost precisely the same manner employed in the other examples; a single instance will suffice, we think, to make this clear. If we draw an element $r\,s$, it will correspond in the direct end view to the point r'', and in the top view to $r'\,s'$, the distance $t'\,r'$ being equal to $t\,r''$; or r' may be found by projecting r vertically upward to the ellipse; then s' is found by the intersection of $r'\,s'$ with the circle representing the larger cylinder in the top view, and s is perpendicularly under it. So $l'.p'$ serves to determine p, which is clearly the point on the extreme right of the curve, and the latter is there tangent to a vertical right line.

The development of the vertical cylinder, with its openings, involves no new principles, and we might have left it for the reader to construct, but that the nature of the case is such as to afford opportunity to give one or two hints in regard to laying out this development, and others of like character, for the use of the workman. We will therefore suppose the cylinder V to be cut open along the most remote element, z' in the top view, and unrolled to the right and left; then, supposing the external surface still to be nearest us, lay the sheet down so that the opposite or nearest element, w' of the top view, coincides with the indefinite centre line L L of Fig. 242. This will then divide the rectangle A B C D into two equal parts, and the opening for the cylinder H will appear in the right-hand, that for I in the left-hand portion, an arrangement which has an evident natural relation to the positions of the two cylinders in the front view. Now bisect D L, and through the point of bisection draw a vertical centre line M M; this will evidently divide the opening for the cylinder I symmetrically, and on it will be found the highest and lowest points, m and v. The greatest

The development of the shell of the horizontal cylinder H, which is shown in Fig. 243, involves no new principle: in regard to the element on which it should be cut, it may be noted that it would perhaps be advisable to select the most remote one, $g'\,h'$ in the top view of Fig. 241, because in that case the developed curve will be symmetrical with respect to the element $c'\,d'$ on the opposite side, as shown.

But when we come to the development of the inclined cylinder, I, we are confronted by a new state of things. The upper base is a plane, to be sure; but it is not perpendicular to the axis, and we have already seen that it will not develop into a straight line: and as for the lower end, that is still worse.

However, we know that any circle on a cylinder, the plane of which is perpendicular to the axis, will develop into a right line; all that is necessary then is to draw one, as shown at E F in the front view; the position is wholly immaterial. To construct the development, Fig. 244, draw first the line E′ F′ equal to the circumference of this circle; then draw ordinates above and below, on which set off distances equal to the segments into which the corresponding elements are cut by E F in the front view. Thus, if the cylinder be split on the upper or shortest element $m\,n$, we set off E′ m equal to E m of the front view, and below E′ F′, set off E′ n equal to E n. So also $u\,v$ of Fig. 244 is equal in length to $u\,v$ of Fig. 241, and the parts u G, v G, of the former are respectively equal to u F, v F, of the latter. And in like manner we may determine any number of points: the advantage of sub-

its direction, and should be made use of whenever it is practicable.

The point of tangency in the developed curve will be at the same distance from the vertex as in the original position; this distance is evidently $v\,r$ in the front view, which is therefore set off as V P in Fig. 246. Other points in the curve may be found by either of the two methods before given: Thus, by making B K equal to $b'\,k'$, drawing V K, and setting off V M equal to $v\,l$, the true distance from v to m, we find M. Otherwise, this point may be found by describing about V an arc with radius $VT = v\,l$, and setting off on this arc T M equal to the arc $t\,m'$ in the top view.

The development of the cylinder is given in Fig. 247, but it involves no new features, and by the aid of the letters of reference the reader will be able to perceive its relations to the cylinder before development, and to trace its construction, without explanation.

Figs. 248 and 249 are introduced in further elucidation of the statement previously made, that the section of a cylinder by a plane inclined to the axis at an angle of 45°, would leave the cylinder of the proper form for part of what is called a "square elbow" like that of a stove pipe. If we suppose the cylinder shown thus cut in Fig. 248 to be made of wood, and, boring a hole in the centre of each section perpendicularly to its plane, place therein a pin $p\,p$, on which the pieces may turn freely, it will be clear to the least imaginative reader that the upper piece may be turned round on this pin until it comes into the horizontal position shown in Fig. 249, when the two sections will again coincide, the left-hand element $a\,b$ of the upper piece being now the lowest, and $c\,d$ the right-hand one, being the highest. In other words, $b\,d$, the major axis of the upper elliptical section is simply turned, end for end, after which it is clear that the two ellipses will coincide as before. Now the section, of a cylinder by a plane making any angle with the axis except a right angle is an ellipse; and if we cut another cylinder of the same size by a plane inclined to its axis at the same angle, it will be seen that the two ellipses thus formed are equal and similar, and may be applied to each other so as to coincide in two positions, in one of which the axes of the cylinders will coincide, while in the other the axes will be inclined to each other; and the angle included between them will be twice as great as that made by the plane of section with the axis of either.

This is illustrated, as applied to a practical purpose, in Fig. 250: the vertical cylinder V and the inclined one I are cut by the plane $a\,c$, the angle $c\,m$ D being equal to the angle $c\,m$ F; therefore the angle D m F between the axes is equal to the sum of the two, or twice either.

The drawing represents an elbow of three pieces, which is laid out as follows: Draw an indefinite centre line E F, making an angle of 45° with the horizontal and vertical lines, and G K perpendicular to E F, intersecting it at l. From l set off on G K the distances $l\,o$, $l\,p$, equal to the semi-diameter of the pipe. Supposing $c\,d$, the length of the shortest element of the centre piece, to be known, draw through o a parallel to E F, and set off $o\,c$, $o\,d$, each equal to half this length. Draw c a horizontal line, and set off on it $c\,e$ and $e\,f$, each equal to $l\,o$; draw through e the vertical axis C D, and through c and f the vertical outlines of the cylinder V. Through p draw a parallel to E F; this parallel, $a\,b$, is the upper outline of the centre piece I, and will intersect the left-hand element $f\,a$ of the vertical pipe V in some point a. Draw $a\,c$, which, if the work be correct, will pass through m, the intersection of C D and E F, and bisect the angle D m F. In like manner, the vertical line $d\,r$, equal to $l\,o$, will locate the horizontal axis A B, which will intersect C D in some point of G K, which may or may not coincide with p; and $r\,s$, also equal to $l\,o$, fixes the position of the upper element of the horizontal piece H, which will cut $a\,b$ in b, whence we draw $b\,d$, which should pass through n and bisect the angle E m B. Also $a\,c$ and $b\,d$, when produced, will intersect in some point x on G K, and the latter line will bisect the angle between C D and A B.

The construction of V′, the development of V, is precisely similar to the like operation explained in connection with Figs. 212 and 215, and needs no more words. And as for that of I′, the development of I, it will be seen that it will be bounded on the opposite sides by two curves, identical with that of the upper edge of V′, separated by a distance equal to $c\,d$. As in the other cases, no allowance is here made for laps at the joints, which is a matter to be left to the practical judgment of our friends, the workers in sheet-metal, as it evidently depends on questions relating to the thickness and the nature of the metal itself, the actual dimensions of the pipe, the kind of joint to be made, etc., all of which are beyond the draughtsman's province to decide.

BRITISH ASSOCIATION.

CENTROIDS.

PROFESSOR A. B. W. KENNEDY read a paper on "Centroids, and their application to some Mechanical Problems." The object of the paper was to suggest the use of general forms for some of the more important theorems of elementary mechanics commonly treated as very limited cases. The lecturer made use for this purpose of foci curves called centroids, which he explained to be of the instantaneous centres of motion of the bodies whose motions are to be studied. After explaining the nature and mode of determination of centroids, he showed their application to several fundamental problems in kinematics and dynamics in detail, illustrating the theorems by diagrams of various mechanisms. He concluded with the hope that these illustrations might be useful for educational purposes, especially in that higher education of engineers, and others interested in mechanical problems, by the use of one general method throughout a great number of special cases, instead of a special and different method in those cases which themselves were essentially identical.

ACTION OF ALCOHOL ON THE BRAIN.

Mr. C. T. Kingzett read a paper "On the Action of Alcohol on the Brain." He said the question of what became of alcohol taken into the system had been extensively studied. Thudichum was the first to determine quantitatively the amount of alcohol eliminated by the kidneys from a given quantity administered, and the result he obtained was sufficient to disprove the elimination theory then widely prevailing. Dupré and many others continued these researches, from which, according to Dupré, they might fairly draw three conclusions—1st, that the amount of alcohol eliminated per day did not increase with the continuance of the alcoholic diet; therefore all the alcohol consumed daily must of necessity be disposed of daily, and, as it was certainly not eliminated within that time, it must be destroyed in the system; 2d, that the elimination of alcohol following the taking of a dose was completed twenty-four hours after the dose was taken; and 3d, that the amount eliminated in both breath and urine was a minute fraction only of the amount of alcohol taken. In 1839 Dr. Percy published a research on the presence of alcohol in the ventricles of the brain, and, indeed, he concluded, "that a kind of affinity existed between the alcohol and the cerebral matter." He further stated that he was able to procure a much larger proportion of alcohol from the brain than from a greater quantity of blood than could possibly be present within the cranium of the animal upon which he operated. Dr. Marcet, in a paper read before the British Association in 1859, detailed physiological experiments which he considered to substantiate the conclusions of Dr. Percy, inasmuch as they demonstrated that the alcohol acted by means of absorption on the nervous centres. Lallemand, Perrin, and Duroy had, moreover, succeeded previously in extracting alcohol from brain matter in cases of alcoholic poisoning. But all these researches left them entirely in the dark as regarded the true action, if any, of alcohol on cerebral matter, and no method of investigation was possible until the chemical constitution of the brain was known. Thudichum's researches in this direction, together with some more recent and published investigations by Thudichum and the author, had placed within reach new methods of inquiry regarding the action of alcohol on the brain. In his research he (Mr. Kingzett) had attempted this inquiry by maintaining the brains of oxen, at the temperature of the blood, in water, or in water containing known amounts of alcohol. The extracts thus obtained had been studied in various ways, and submitted to quantitative analysis, while the influences exerted by the various fluids on the brain had been also studied. These influences extended in certain cases to hardening and to an alteration in the specific gravity of the brain matter. Water itself had a strong action on brain matter (after death), for it was capable of dissolving certain principles from the brain. These principles included cerebrine, myeline, and apparently a new phosphorized principle insoluble in strong alcohol, together with that class of substances generally termed extractives. At the same time the brain swelled and attained a smaller specific gravity; thus in one case from 1036 it became 1007. It was notable that water, however, dissolved no kephaline from the brain. Alcohol seemed to have no more chemical effect on the brain than water itself, so long as its proportion to the total volume of fluid did not exceed a given extent. The limit would appear to exist somewhere near a fluid containing 35 per cent of alcohol. But if the percentage of alcohol exceeded this amount, then not only a larger quantity of matter was dissolved from the brain, but that matter included kephaline. Such alcoholic solution also decreased to about the same extent as water the specific gravity of brain substance, but not from the same cause; that was to say, not merely by the loss of substance and swelling, but by the fixation of water. Many difficulties surrounded the attempt to follow these ideas into life, and to comprehend in what way these modes of action of water and alcohol on the brain might be influenced by the other matters present in blood. From Thudichum's researches it followed that the brain must be subject to every influence affecting the blood, and it was probable that what was written above regarding the action of water on the brain was likewise true of an extraordinary water serum in life. But if the serum were rich in salts, those salts, by a power of combination which they had for the cerebral principles, would preserve the integrity of the latter. On the other hand, it was difficult to see how any of the matters known to exist in the blood could prevent alcohol, if present in sufficient amount, from either hardening the brain (as it did after death) or dissolving traces of the principles to be henceforth carried away in the circulation; that was to say, should physiological research confirm the stated fact that the brain in life absorbed alcohol and retained it, it would almost follow of necessity that the alcohol would act as he had indicated, and produce disease, perhaps *delirium tremens*.

A STEAM LAMP.

Mr. R. Lavendar, Kirkcaldy, read a paper descriptive of a lamp specially adapted for collieries, the merit of which was that it gave a great light at a small cost. The lamp, as shown at Kelvin Grove Museum, consists of a glass lantern 18 inches square, with a funnel 24 inches high. Into this is introduced a jet of steam, about one sixteenth inch in diameter, the object of which is to create a partial vacuum in the lantern. The consequence is, that the surrounding air is forced through the burner of the lamp, causing almost complete combustion of the oil. A very brilliant light is thus produced, which is increased partly owing to the products of combustion being continuously removed and a volume of fresh air being introduced. The results obtained from a 4-inch wick had been equal to a light of upward of 600 sperm candles.

EXPERIMENTS ON THE TURNING OF SCREW STEAMERS.

Professor Osborne Reynolds read the report of a committee, consisting of Sir W. Thomson, Mr. J. R. Napier, Mr. W. Froude, and Professor Reynolds, appointed at Bristol last year to make experiments on the turning of screw steamers. The committee obtained the use of three vessels, in which various trials were made. In the first place, experiments were conducted on 6th June last with the "Valetta," an 80-ton yacht belonging to the Earl of Glasgow, between Wemyss Bay and the Cumbrae. Her screw was right-handed. The first trial was as to the effect which the screw exerted to turn the ship with the helm amidships. When at full speed she turned to port at the rate of about 7° per minute—or, as it was usually expressed, she carried a port helm. However, as the speed of the engines was reduced, the tendency to turn the ship to port was reduced, and, when going very slow—about five knots an hour—the ship turned slightly in the opposite direction. When going fast, the screw churned air into the water, but not when going slow. The effect of the screw to turn the ship with the helm amidships, although appreciable, was not of sufficient magnitude to be taken into account in the results of the subsequent experiment, and as this effect was almost the same with the wind on either bow, it was evident that although the wind was blowing with some little force, its effect to turn the vessel was also unimportant. These preliminaries having been settled, the ship was driven full speed ahead, then the screw reversed as suddenly as possible, and immediately as soon as the screw began to turn astern the rudder was put hard over. At reversal the engines turned but slowly, and it was not until the boat had lost some of her way that they turned full speed astern. Four observations were taken in this way with helm to port, two with head to wind, and two before the wind, and similar observations were taken with the helm to starboard. All four observations with the helm to port gave nearly the same results, and so with the helm to starboard. After giving the mean results, the committee went on to say that with this ship, although the reversing of the screw did not at once reverse the action of the rudder, it greatly reduced its effect, and reversed it in time for the ship to have turned 8° out of her course before she had come to rest. Experiments were afterwards made with one of the hopper barges, with a right-handed screw, belonging to the Clyde Trust. In the case of this vessel, the effect of reversing the screw was to cause her to turn through more than 30° from the direction in which she headed when the reverse action set in; and considering that in the same time she would have turned through 60° in the opposite direction had the engines been kept on ahead, the effect of reversing was to turn her through 90° from the position she would have occupied had the engines kept on ahead. The concluding experiments were made with the steam yacht "Columbia," belonging to the Duke of Argyll, fitted with a Griffith screw. When the vessel was going full speed ahead (about 10 knots) the engines were reversed and the helm immediately put to starboard, when the vessel turned to starboard until her forward way was lost, the time between the reversal of the engines and the stopping of the ship being about one minute. When the vessel was going full speed ahead the helm was set to port, and shortly after the screw reversed. The vessel turned to starboard at first and then to port until all way was lost. The turning to starboard at first was the natural result of the helm having been ported before the screw was reversed. In all three vessels the same effect on the steering was produced by the reversing of the screw when the vessel was at full speed.

Professor Reynolds afterward read a paper on the "Investigation of the Steering Qualities of Ships." In the course of this paper, he remarked that the uncertainty which at present existed in the manœuvring of large ships was amply proved by the numerous collisions which had occurred between the ships of our navy while endeavoring to execute ordinary manœuvres under the most favorable circumstances and with no enemy before them.

NEW STANDARDS OF MEASURE AND WEIGHT.

Professor Hennessy read a paper on "New Standards of Measure and Weight." He said that owing to the objections many persons still entertained to the metric system, he brought forward for consideration the standards which he had prepared several years since, and which had been subsequently advocated by Sir John Herschel. The standard of measure was a bronze prismatic scale, which was the fifty-millionth part of the earth's polar axis. From that a system of weights was derived by taking a fraction of the standard of length as the side of a cube, and finding the weight of an equal volume of distilled water. In that way a series of weights were constructed in bronze. A chain containing 50 links, each equal to the bronze standard, was also constructed, and that chain was therefore the millionth part of the earth's polar axis. The link or standard scale measured very nearly 10.0097 English inches, and its tenth part was therefore very little in excess of an inch. That, as well as the geometrical superiority of the axial standard over one derived from a meridian, seemed to have influenced Sir John Herschel and others in preferring it to the metre. Geometrical measurements had in fact shown that the earth was a somewhat irregular spheroid, and therefore that its meridians were unequal, while the polar axis was necessarily unique, and corresponded to every meridian. On these grounds Professor Hennessy thought that the new standard might be universally accepted by all nations if the objections to the metre would prevent its general adoption.

NEW MINERALS, ETC.

Professor Von Lasaulx, of Breslau, exhibited specimens of a new mineral which he described, from its behavior before the blow-pipe, under the name of Melanophlogite. It crystallized in small cubes, which were seated on crystals of sulphur and celestine from Girgenti in Sicily. The mineral contained 86 per cent of silica, 3 per cent of water, small quantities of iron and strontium, with 7 per cent of sulphuric acid or some acid of the thionic series not yet determined. The Professor also describes certain garnets which exhibited the phenomena of double refraction.

Professor F. W. Rudler made some remarks on the value of this communication, and on the extraordinary chemical constitution of melanophlogite. He also referred to various anomalies among monometric minerals, such as boracite, senarmentite, and alum, and gave an explanation of the means by which such anomalies had been explained. Reference was also made to Biot's theory of lamellar polarization, to the effect of tension, and to those of decomposition, as explaining the anisotropic characters of those crystals.

A NEW VOLTAIC CELL.*

SOME months ago, requiring for experimental purposes a battery of high E. M. F., it was suggested that I should try one invented by Mr. D. G. Fitzgerald. Previous to this I had seen the battery at work for telegraphic purposes, and had understood that it was found to be very effective and economical.

The cell has been made in various forms, and as in one of its shapes especially it differs considerably from the cells in ordinary use, I thought perhaps a short account of it might be interesting to this section. As will be seen, in the form which has been devised for ordinary use, depolarization takes place by means of a secondary current, and, as I believe this current increases directly as the polarization, and does not interfere with the primary or working current, we get a very good example of a constant battery.

The form of cell I have used in my researches is differently constructed. A cylindrical glazed earthenware jar (size varying—largest about 12 or 14 inches deep by 6 or 8 diameter) is taken. Six or eight carbon plates, cylindrically fastened by means of an alloy of lead and antimony into an iron ring fitting the top of the jar, form the positive pole of the battery. A porous earthenware diaphragm is placed in the centre of the large jar, and contains a cylindrical or a flat piece of Zn, to form the negative pole. The internal resistance of this cell is only about $\frac{1}{4}$ or $\frac{1}{3}$ of an ohm, whilst the E. M. F. is somewhat over 2 volts.

The form of cell for general purposes is rectangular in shape. The cell is divided into two liquid-tight compartments by a plate of perforated carbon, the perforations being $\frac{3}{8}$ in. or $\frac{1}{2}$ in. in diameter, into which are tightly glued plugs of porous earthenware. The number of perforations vary with the size of the cell. The carbon plate is the positive pole of the cell. The negative is formed by a plate of amalgamated Zn placed in one of the divisions. The Zn is about $\frac{2}{3}$ of the height of the cell, and a little less than the width of it, and is held in its place by means of a screw clamp, which enables connections to be made with Zn. A binding screw is fitted to the top of the carbon plate, and the cell is complete.

The cell is charged by filling up the Zn compartment with

* Paper read before Section B of the British Association by C. H. W. Biggs.

dilute H_2SO_4 (1 acid to 10 OH_2), and the other compartments with a strong oxidizing agent. The best oxidant for this purpose is calcic dihydrochromate, with sufficient H_2SO_4 to combine with the base (CaO), and with the sesquioxide of chromium produced when the calcic salt is dioxidized, forming chromium sulphate. It is very easily prepared by mixing in the proportions of 5½ ozs. of chromate of lime (calcic chromate) with 4¼ fluid ozs. of concentrated sulphuric acid. It is found best to mix the acid and the calcic chromate in the cell itself, thus:—Partially fill the cell with water, add the calcic chromate, and then gradually the H_2SO_4, in order to avoid the ill effects on cell which otherwise might be produced by the sudden generation of a large quantity of heat. The proportions given are to be used for every 2½ or 3 fluid ozs. of H_2SO_4 used in the Zn compartment. The quantities to be used may be obtained from the full equation:—

$$H_2Ca2CrO_4 + 4H_2SO_4 = CaSO_4 + Cr_23SO_4 + 5H_2O + 3O.$$

The three atoms of oxygen oxidize three molecules of hydrogen produced by the reaction of zinc and sulphuric acid. Thus the battery equation is:—

$$3Zn + H_2Ca2CrO_4 + 7H_2SO_4 = ZnSO_4 + CaSO_4 + Cr_2SO_4 + 8H_2O.$$

As I have previously said, an intense current is generated by this form of battery. There is no porous diaphragm to increase resistance (the plugs not being traversed by the primary current), and the poles are very near to each other.

The depolarizing or secondary current may thus be explained:—

First, in the compartment containing the oxidant any hydrogen given off by the C plate would at once be oxidized and rendered harmless. Thus C, and C alone, is exposed.

Secondly, in the Zn compartment, when the cell is working, H is deposited on surface of the C plate. This causes a difference of potential to be established between the two sides of the carbon plate, and a current commences, the circuit being completed through the porous plugs and through the plate itself. By this current the H is oxidized as fast as it appears on the surface of the carbon plate, which is thus wholly kept free from hydrogen or polarization.

Here, then, we obtain the maximum E. M. F. of C and Zn, which is obtained in no other cell with which I am acquainted, except it be the chromic acid cell; and also there is no consumption of Zn when the cell is not working.

Although perfect in theory, it is, however, not quite so in practice—although it is difficult to conceive any battery which comes nearer perfection. Under ordinary conditions the current is constant, and if a battery be set to work through an external resistance, which is equal to its internal resistance—that is if the battery be tested under conditions when the greatest effect be obtained—the current is fairly constant till the solutions are exhausted. If, however, the battery is short-circuited, there is a gradual but slight diminution of current till a certain point is reached, when the current remains constant.

One of the most interesting features of this battery is, perhaps, the value of the residue after exhaustion of working powers.

The soluble residual matter should consist of sulphate of zinc and sulphate of chromium—thus,

$$3ZnSO_4 + Cr_23SO_4,$$

together with a quantity of water.

The separation of these sulphates has not yet been effected. However, by treatment in a variety of ways, a series of pigments can be obtained, which ought to be of great value in the arts.

By adding common salt to the residue we get on boiling chlorides of zinc and chromium and sulphate of soda; the latter, on cooling, crystallizes out. If to the remainder be added 4 equivalents of PbO for each of NaCl, we get oxides of chromium and zinc and oxychloride of lead, which gives this pigment (pigment shown).

If carbonate of baryta is added to the crude residue, as shown by equation

$$3ZnSO_4 + Cr_23SO_4 + 6BaCo_3 = 6BaSO_4 + 3ZnO + Cr_2O_3 \; 6CO_2,$$

a very pale green color is obtained. If, however, chalk is cautiously added instead of carbonate of baryta, we get a deeper color.

It is admitted that a good green without arsenic is a desideratum; and it seems by this means it can be obtained. As, however, a large number of experiments, extending over a long period of time, have been made, and as the investigation is not yet completed, it may be as well to reserve further details for a future paper.

TELEPHONY.

AUDIBLE SPEECH BY TELEGRAPH.

THE following interesting account of an experiment made on the evening of October 9, by Prof. Alexander Graham Bell and Thomas A. Watson, is from the *Boston Advertiser*. Telephones were placed at either end of a telegraph line owned by the Walworth Manufacturing Company, extending from their office in Boston to their factory in Cambridgeport, a distance of about two miles. The company's battery, consisting of nine Daniell cells, was removed from the circuit, and another of ten carbon elements substituted. Articulate conversation then took place through the wire. The sounds, at first faint and indistinct, became suddenly quite loud and intelligible. Mr. Bell in Boston and Mr. Watson in Cambridge then took notes of what was said and heard, and the comparison of the two records is most interesting, as showing the accuracy of the electrical transmission.

The telephones used were a species of drums, open at one end, the skin at the opposite end being connected with the circuit breaker.

BOSTON RECORD.	CAMBRIDGEPORT RECORD.
Mr. Bell.—What do you think was the matter with the instruments?	Mr. Bell.—What do you think is the matter with the instruments?
Mr. Watson.—There was nothing the matter with them.	Mr. Watson.—There is nothing the matter with them.
B.—I think we were both speaking at the same time.	B.—I think .... at the same time.
W.—Can you understand any thing I say?	W.—Can you understand any thing I say?
B.—Yes; I understand every thing you say.	B.—Yes; I understand every thing you say.
W.—The reason why you did not hear at first was because there was a relay in the circuit.	W.—The reason why it did not work at first was because there was a relay in the circuit.
B.—You may be right, but I found the magnet of my telephone touching the membrane.	B.—You may be right, but I find .... that my .... touches the membrane.
W.—I cut this relay out, and then the sounds came perfectly.	W.—I cut the relay out, and then the sounds came out perfectly.
B.—I hear every syllable. Try something in an ordinary conversational voice.	B.—I hear every syllable. Try something in a conversational voice.
W.—Shall I connect their battery in the circuit?	W.—Shall I connect their battery in the circuit?
B.—No; there is no necessity to connect their battery in the circuit, for the sounds come out quite loudly.	B.—No; there is no necessity for putting their battery in the circuit, as the sounds come out quite loudly.
W.—I am now talking in quite a low tone of voice.	W.—I am now talking in quite a low tone of voice.
B.—The sounds are quite as loud as before, and twice as distinct.	B.—The sounds are quite as loud as before, and quite as distinct.
W.—Cut out the battery and then talk.	W.—Cut out the battery and then talk.
B.—All right, I will cut out the battery now if you will keep listening.	B.—All right, I will cut out the battery now if you will keep listening.

[Here an interruption occurred, and after a short time Mr. Bell said:]

B.—I thought you were going to say something.	B.—I thought you were going to say something.
W.—Is the battery cut out?	W.—Is the battery cut out?
B.—No, but I will do it now.	B.—No, but I will do it now.

[Battery having been cut out, Mr. Bell continued:]

B.—Do you hear any thing now?

[Battery replaced.]

B.—Did you hear any thing?	B.—Did you hear any thing?
W.—No, not a sound.	W.—No, not a sound.
B.—Say something to me when I cut out the battery again.	B.—Say something to me when I cut out the battery again.

[Battery cut out.]

W.—....	W.—I could not hear a sound when the battery was cut out.

[Battery replaced.]

B.—I fancy I heard a trace of your voice.	B.—I fancied I heard a trace of your voice.
W.—Shall I put on our battery to see if it increases the effect?	W.—Shall I put on their battery to see if it increases the effect?
B.—I'll tell you what we'll do. We'll take off our battery and put on theirs, as before.	B.—I'll tell you what we'll do. We'll take off our battery altogether and put on theirs, as before.

[The company's battery having been placed in circuit, faint and indistinct sounds were heard at the Boston end, and then came the intelligible sentence:]

W.—Is our battery off?	W.—Is our battery off?
B.—Yes, our battery is off. What have you been doing? The sounds were quite soft at first, but now they are quite loud.	B.—[Very indistinct—unintelligible.]
B.—Shall I put on our battery again?	
W.—[Indistinctly heard.] That was very indistinct. Put on our battery.	W.—That was very indistinct. Put on our battery.

[Original battery replaced.]

B.—We may congratulate ourselves upon a great success.	B.—We may congratulate our selves on our great success.

PHOTOGRAPHS UPON ENAMEL AND PORCELAIN.

A BRANCH of our art little or not at all practised in Germany is the production of unburnt-in photographs upon opal glass, enamel, porcelain, or alba plates; yet the results have such an extraordinary beauty and artistic effect that the process deserves greater attention. These pictures have until now only been produced by a few Parisian photographers, and their mode of production has been kept secret; but in England the attention paid by photographers to this sort of picture is greatly on the increase. We place before our readers two processes, the second of which we have practically tested and found it worthy of recommendation.

When one has to do with a flat surface the picture may be copied directly from the negative; but it is better to use a copying camera, because then one can get copies of any desired degree of enlargement or reduction from the same negative. The copying camera is well known, but it will not be out of place to describe briefly a contrivance which can easily be affixed to any camera in order to copy negatives. The lens is fixed into the camera as usual. A passage, folding bellows-wise, is placed in front of the camera in order to shut off all side light from the objective. At the end of the passage, farthest away from the camera, an arrangement is made by which negatives of different sizes may be fastened in position, and one centimetre in front of the negative a ground glass is placed. In front of the latter a mirror is set so that it may be unfastened and lowered until the diffused light, reflected upon the ground glass and softened by it, falls upon the negative and illuminates it equally.

If the enamel picture be desired to be larger than the negative the latter is pushed, along with the passage, towards the camera; if the picture be desired smaller the proceedings are reversed, and the exact focus will then be found behind the camera. The negative being focussed to the desired size, an alba plate or opal plate is prepared with a negative collodion, which gives very fine details; the silvered plate is placed in the dark slide, sufficiently exposed and developed in the usual manner, but without being intensified with silver.

If it be wished to produce the pictures upon oval and convex enamel plates, of course it is evident that an especial dark slide will be required; or, if the ordinary dark slide be deep enough to receive the enamel plate, the latter may be held in place by an oval mat. The picture may be previously focussed with the same mat placed in the ordinary ground glass frame, and with an oval glass prepared for the focussing by means of a mat varnish.

According to one process, taken from the *Photographic Times*, the picture is developed with iron, fixed with soda, and, after being carefully washed, toned in the following way:—One gramme of chloride of gold is dissolved in sixty grammes of water. Four grammes of the foregoing solution are used to sixty grammes of water, and the whole is poured equally over the picture until the latter has assumed a light rose tint, whereupon it is again well washed with water.

Of a saturated stock solution of mercuric sublimate take four grammes and mix with thirty grammes of water. This solution is poured upon the gold-toned plate, which soon assumes a deep purplish-black tint, and allows the picture to develop brilliantly.

The French method of producing pictures upon enamel plates is somewhat different from the foregoing. Instead of the iron developer they are developed with pyrogallic acid:—

Water	250	grammes.
Pyrogallic acid	2	"
Citric acid	2	"

A somewhat longer exposure is required than with the iron developer; yet for this purpose the picture appears finer. When the picture is sufficiently developed it should be very carefully rinsed with water and fixed with cyanide of potassium.

Solutions to be prepared beforehand for the Toning Bath: 1. Seven grammes of chloride of mercury in 100 grammes of water. 2. Three grammes of chloride of gold in 400 grammes of water. To 100 parts of water add ten parts of each of the previously prepared solutions, and pour over the picture. This process also requires to be carefully watched until the desired strength has been attained, after which the picture is again carefully washed and some diluted ammonia poured over it. Lastly: if necessary, the picture is retouched and varnished.

These pictures on enamel plates may be very beautifully and effectively colored either in oil or water colors. If in that case it be desirable to re-varnish, a turpentine varnish must be chosen which shall not dissolve the first spirit varnish.—T. H. VOIGT, in *Photographische Monatsblätter*.

EMULSION PHOTO PLATES.

By HENRY J. NEWTON.

Formula for Collodion.

Alcohol	2½ ounces.
Ether	6 "
Wood naphtha	1½ "
Cotton	8 grs. to the oz.
Bromide of cadmium	12 " " "

To make the emulsion, add eighteen grains of fused nitrate of silver to the ounce in boiling alcohol. This gives three grains of silver in excess. When the excess of silver has acted upon the organic matter of the collodion for about eight hours, it is converted into a chloride with hydrochloric acid. It reaches its maximum point of sensitiveness in ten or twelve hours, and usually enters the foggy condition in that time, and it requires a week or more to work clear after adding the acid, if left that length of time. The free silver can be permitted to act longer on the collodion when hydrochloric acid is used to convert it into a chloride, than when the chloride of cobalt or calcium is used.

I determine the strength of my hydrochloric acid by dissolving ten grains of nitrate of silver in half an ounce of water, and with a dropping tube (which I never use for any other purpose) drop in the acid until the silver is all converted into a chloride.

After having determined the number of drops required to convert ten grains of silver nitrate into a chloride, I keep this sample of acid for this particular use.

This is necessary from the fact that hydrochloric acid varies somewhat in the volume of chlorine which it contains. I usually add a few drops more than is necessary to convert all the silver. To make sure that all the free silver has been removed I flow some of the emulsion on clean glass and expose to the light for a short time, and then apply some of the ordinary iron developer. If any free silver remains it will discolor under the action of the iron, and acid should be added until no change is produced by the combined action of light and the iron developer.

Emulsion made in this way should work clear the next day after compounding, but will improve for a week, and will be found to change very little in a year. The sensitiveness can be increased by increasing the quantity of silver. Twenty grains instead of eighteen will add to its sensitiveness. I should prefer in this experiment to have the formula as given strictly adhered to. The use of the wood naphtha makes the solution of the cotton more complete, and therefore a more even-flowing emulsion.

This emulsion can not be used successfully with a strong preservative. The preservative to be used is compounded as follows:

Water	12 ounces.
Syrup of squills	1 drachm.
Tincture of nux vomica	1 "
Laudanum	1 "

Let this stand twenty-four hours and filter. This preservative can be used for months. It is not absolutely necessary to let it stand twenty-four hours, as it will give good results immediately after compounding, but I think it gives better after a little age.

Plates prepared with this emulsion should not be washed before immersing in this preservative, but should be put into it as soon as sufficiently set, and when the greasy lines are washed off it is ready to be removed, and can be set away to dry or can be used wet.

In my experiments I always use them wet; they are, however, more sensitive when dry.

To develope, make a solution of

Concentrated ammonia	½ ounce.
Water	½ "
Bromide of ammonia	10 grains.

This is stock-bottle No. 1.

When ready to develop, dissolve in one ounce of water from two to six grains of pyrogallic acid; it is not very material about the strength of the pyro solution, but it must be in water, as the alcoholic solution will not give satisfactory results with this mode of developing plates prepared with this emulsion.

After the plate has been exposed and washed under the tap, flow it with sufficient of the pyro solution to cover it well, flow off and on until the outlines of the image appear; then pour the pyro into a vial containing six or eight drops of solution No. 1, and reflow the plate, when the required intensity will immediately be attained.

Two drops of a solution of chloride of gold, eight grains to one ounce of water in eight ounces of emulsion, makes a marked difference of sensitiveness.

The quantity of gold can be increased a drop at a time, until that part of the plate treated with it will turn blue under the action of the light in the camera, before the rest of the plate is exposed sufficiently to show but the faintest trace of an image under the developer.—*Photographic Times.*

HOW TO USE PHOTOGRAPHIC BACKGROUNDS.

By L. W. SEAVEY.

[With Fourteen Illustrations.]

DURING the recent Photographic Congress at Philadelphia, Mr. L. W. Seavey read the following paper on the above subject, for which and the accompanying engravings we are indebted to *The Philadelphia Photographer*:

Every background is painted for some particular kind of picture, or to produce some particular effect. Shadows are placed here, and lights there, that when you place your subject before it, the features and drapery will be so relieved that the figure will seem to stand forth from the background. Great pains is taken that lines may not intersect those of the figure at points that will produce unpleasant angles.

I may mention here Mr. Ormsby's paper on artistic sight, the value of which I fully appreciated. I remember that when I first began to pay attention to painting I used chiefly pure colors, and not long ago I was reminded of my former method by hearing an artist say that the same was true of all amateurs; hence their pictures are usually crude, and delicate only after they have had experience. They subdue their colors and mix them with white, making them more neutral; the result of it is that when you examine a good oil painting or a water color, you hardly see traces of the pure colors of the palette. The tints are almost indescribable. You don't know exactly how they are made. After you have had experience in handling these colors you can then perhaps solve the problem.

I remember in my early experience looking through a camera at a sitter; I could not see where the shadows were that afterwards developed themselves on the plate, and I have no doubt that many young photographers, in posing their subjects, put them in certain positions because they know a good effect will be produced, although they are not able to see in the camera the shadows just mentioned. Now, a painter learns to arrange lines and shadows by drawing figures, landscapes, and architecture; and were the photographer to draw his figures, he would realize the necessity of a good arrangement of light, shade, and the principal lines. As photographers you can scarcely appreciate that, I am afraid. I know that in painting theatrical scenery in order to make one object stand prominently forward as the subject of the picture, we have to put either a broad shadow behind it, and put the figure in light against the broad shadow, or reverse the process. Doré's pictures, if you examine them closely, reveal that they are very simply constructed, so far as light and shade are concerned. In one of the scriptural subjects that I have seen, the figures are placed on elevated ground in shadow against a light sky. (Sketch No. 1.) Another thing that probably applies to photography as much

FIG. 1.*

Breadth of light-shade from Doré.

as to painting, is that the artist's character is impressed indelibly on his work. If he is a refined, intelligent, and cultivated man, you will see it in his pictures. If, on the contrary, he is gross, boorish, uncultivated, you will see that. If he is an awkward man you will see the same in his pictures. He will pose his subjects as he feels himself, and according to his understanding. Notwithstanding his subjects may be awkward, if he is an intelligent and a refined man, if he has a high idea, it will still be manifested in the posing. We see that more particularly in painting. A man who is a rough, coarse man, will produce pictures which will be stiff and angular. He will use dark browns, sombre greens, strong colors, and he will paint more with the pure colors from the palette than from tints produced therefrom.

I am acquainted with quite a number of scenic artists in New York, and I have taken a great deal of pleasure in noticing the similarity of their paintings to the character of the men themselves. Now, in photography, I have noticed in the exhibition down here that there are some pictures that are what we would call weak—there is a large amount of light in them. A rambling arrangement of accessories, no broad shadows, and no grand effect or high ideal. If a man is weak in his character, if he is insipid in his conversation, you will see it in his paintings or in his photographs. If he is energetic and full of vim you will see that in the posing of his figures. I hardly need mention names, but to illustrate probably the extreme of energy as manifested in photography, I may mention one of our highest lights in the profession, Mr. Sarony, of New York; and there are other photographers possessing a great deal of refinement, and you will see it manifested in their photographs.

Engravings and copies of paintings can well be studied and probably understood and better appreciated by photographers than the paintings themselves, because you deal solely in light and shade. As you do not deal in color, you are consequently more or less color-blind; but when the tints in a painting are translated (as I may say) into black and white by engraving, it is then akin to your own work, and you understand it more readily. Our illustrated papers are now publishing engravings of some of the most important figure-paintings of the day, and their low price brings them within the reach of all who have a desire for improvement.

FIG. 2.

Background for Standing figures.

Photographers should surround themselves in the gallery and at home by works of art, not alone by pictures, but by bronzes, plaster, or other casts, according to their means. You don't need necessarily to invest large amounts of money in these, in order to get beautiful forms, because there are many inexpensive productions which you can use to ornament your home and gallery. Their effect will be to refine and elevate, and your work will partake of the higher character of these surroundings. If you surround yourself with rude forms, rude statuary, such as the sculpture of Yucatan and South America of thousands of years ago, they will probably drag you down. But as you surround yourselves with fine forms, fine pictures, and with works that are above you, you are sure to be elevated by them. You will find that they adorn the walls of your reception-room and skylight, and your customer will feel when he enters that he is surrounded by a new influence, that he is in the realm of art, where the beautiful is made a study.

Our brotherhood in photography is as important as it is in painting and sculpture. You all know how the artists of Europe and those in the principal cities in this country are interested, and aid in the exhibitions which are given from time to time. Artists cluster their studios together in one building thus fraternizing; exhibit together in galleries, and

FIG. 3.

Accessories in aiding composition

grow mutually strong. I have no doubt the photographers who attend these conventions from time to time, in comparison with those who do not attend, are the stronger. They are the ones who know their ground. They know where they stand, and are probably the leading ones in the country. There is not, I am sorry to say, a similar union or spirit among the members of the photographic fraternity that there is among the votaries of the brush and pencil; but there is something akin to it in the larger cities. I think it is the duty of photographers to encourage conventions, and particularly photographic journals and photographic literature, for it is by means of this literature that you are all educated, and it is an education that you cannot get in any other way. If you were to isolate yourself from other photographers, from

FIG. 4.

works of art, and the literature of the journals, I do not think your improvement would be very rapid.

I will now make a few sketches illustrating some of the ideas I have in my mind, when I am painting a background for you. (Turning to the wall on which was stretched a sheet of paper three feet by twenty-five feet.)

The first one will be that of a comparatively plain background for a standing figure. I will not attempt to make elaborate figures, but simply sketches; my object being to present the idea and not the details.

We will suppose this (No. 2) to represent a figure of a gentleman. Now, the figure, as you see, stands independently and alone on the background; it has nothing to support it. Now, if the background is made lighter at the top and

FIG. 5.

Arrangement of lines lead to hands.

darker at the bottom (sketching), the interest then instead of being distributed through the whole length of the figure will be directed towards the head, and the lower part of the figure will be scarcely noticeable. The shadows will in a measure blend into the lower part of the background. When you look at it, the first thing you will notice will be the face, as that really should be the most noticeable part.

One of the most difficult things in photography is to pose a full-length figure; but it is still more difficult to pose it without the aid of auxiliaries of any kind. It requires a knowledge of anatomy and composition, which even schools of drawing have difficulty in giving. Now, suppose that you are posing a full-length figure, you will not make it a square front view; of course, with us this is gone by except on rare occasions. And the producing of an object on the background in this case would be by having it dark at the bottom, to still keep the interest at the top and divert the attention from the lower part of the figure. This position is only one of the many kinds that are used when employing the aid of accessories.

This line is broken (indicating), and by the effect of the shadow this portion of the figure (pointing to head and bust) will be prominently brought out.

This figure, in sketch No. 3, is supported by leaning against the shadow, and the shadow serves to break the severe lines that would otherwise be occasioned.

It is well always with full-length figures to convey the idea

FIG. 6.

Lines leading to face

that the figure is doing something, looking towards something, reading or examining the surroundings (sketching). I think it best not to let the horizon line cross the figure at too high a point. You will observe in No. 4 that the horizontal line of the ocean does not have a parallel one in the foreground.

I will now give illustrations of the tendency of lines. The first will be that of a picture I saw in the Russian collection yesterday. This was, I think, a very curious one, and the spectator's eyes were unconsciously directed to the hands of the subject instead of to the face (sketching.)

You see that the effect of the lines in this picture (No. 5) is to lead the eyes of the spectator towards the hands. The lines all come to one point; those of the drapery and those of the accessories all centring in the hands.

No. 6 will be a sketch of a position that you have seen probably many times; it is a simple figure of a lady leaning with her elbow on a table. The light runs down the arm, returns along the forearm and hands to the face, and the light being the strongest there, even if you look at the shoulders first, your eye is led involuntarily to the face.

In order to show you how lines lead to the face I will make sketch No. 7. This figure, of course, depends very much for relief on the background and accessories. All these lines have a tendency to concentrate the interest in the face. This (indicating) is a neutral tint, which relieves the shadow side of the figure. There is sufficient depth of the background to relieve the high lights. Now that would look very different photographed in front of a plain blank wall. The background gradually goes into shadow towards the bottom; and in order

FIG. 7.

that there may be something to relieve the picture and give it force, these accessories, darker than the background, are placed on either side, and the light falling in this direction relieves that whole entire side of the figure.

It is always best to indicate a point from which the light comes. Thus, a light placed in the background as a complementary light to the one on the face should not be of the same strength. The principal light should always or nearly always be the one on the face, and I say to those using my backgrounds, in case the light in them happens to be too strong you can very easily subdue it, and graduate it, so as to produce the desired effect, by the use of ordinary charcoal such as crayon artists use; and in case too great a change has been produced you can dust off the superfluous charcoal with a handkerchief. I mention this, because yesterday a gentleman said he had a background in which the light on the wall was too strong, and he did not know what to do with it.

(To be continued.)